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Catch composition of British Columbia shrimp trawls and preliminary estimation of bycatch – with emphasis on Eulachons

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ABSTRACT

An observer program was started in 1997 to determine the composition of catches in shrimp trawls in British Columbia. The project was intended to sample catches approximately according to the fishing effort, season, area and type of gear. A total of 530 catches were examined: 356 from otter trawlers and 174 from beam trawlers. A specific concern about bycatch in shrimp trawl catches is the catch of eulachons (*Thaleichthys pacificus*). There are relatively few eulachon populations and many have declined sharply in recent years. This paper provides a brief analysis of the relative bycatch in shrimp trawls for all species and provides a preliminary estimate of total bycatch of eulachons (tonnes) in different areas of the coast. The estimates are preliminary because data on fishing effort (duration of fishing time and total tows made) are not yet available. As an alternative to data on effort, we relate the catch of eulachons to the catch of shrimp (bootstrap estimates of the mean and 95% confidence limits) from the *hailed* data on area-specific catches. The *hailed* data are known to be approximations for some areas and may slightly under- or over-estimate total shrimp catches (and therefore eulachon bycatch). We also use the ratio of kg of eulachons to kg shrimp estimated from data collected from the observer program. We used the hailed catches of shrimp from the commercial fishery (estimated in kg for all main Statistical Areas) to estimate the total eulachon catches. The highest bycatch was from otter trawlers in the central coast where the ratio of eulachons to shrimp was 0.210. Therefore, for every 1000 kg of shrimp, 210 kg (95% CL = 173 to 251) of eulachons were caught. When adjusted by total (hailed) catch, an estimated 90 tonnes of eulachons were taken in the central coastal areas. Eulachon bycatch also was high in otter trawls off the west coast of Vancouver Island, where an estimated 52 tonnes were taken. In general, eulachon bycatch estimates were lower in other areas and negligible in the Strait of Georgia. Also, beam trawls had lower eulachon catches, although they took an estimated 22 tonnes of eulachons on the West Coast of Vancouver Island. We conclude with a brief discussion of the biological implications of these catch rates.

RÉSUMÉ

Un programme de surveillance par observateurs a été mis sur pied en 1997 afin de déterminer la composition des captures de la pêche des crevettes au chalut de la Colombie-Britannique. Ce projet avait pour but d'effectuer un échantillonnage des captures en tenant compte, de façon approximative, de l'effort de pêche, de la saison, de la zone de pêche et du type d'engins. Au total, 530 captures ont été examinées : 356 provenant de chaluts à panneaux et 174 de chaluts à perche. On s'inquiétait tout particulièrement de la capture accidentelle d'eulakanes (*Thaleichthys pacificus*) au cours de la pêche des crevettes. Il existe relativement peu de populations d'eulakanes et plusieurs d'entre-elles ont subi un déclin marqué au cours des dernières années. Le présent document donne une brève analyse des captures accidentelles relatives de toutes les espèces faites par la pêche au chalut des crevettes ainsi qu'une estimation préliminaire de captures accidentelles d'eulakanes (tonnes) dans les différentes zones de la côte. Les estimations sont provisoires car les données sur l'effort de pêche (durée de la pêche et total des traits de chalut) ne sont pas encore disponibles. En remplacement des données sur l'effort, nous avons établi une relation entre les captures d'eulakanes et les captures de crevettes (estimations par méthode d'auto-amorçage de la moyenne et des limites de confiance à 95 %) à partir des données transmises par radio pour des zones particulières. Les données des rapports radio sont approximatives pour certaines zones et peuvent sur ou sous estimer légèrement les captures totales de crevettes (et par conséquent, les captures accidentelles d'eulakanes). Nous avons aussi utilisé le rapport entre le poids (kg) des eulakanes et celui des crevettes estimé à partir des données du programme des observateurs. Nous avons ensuite utilisé les captures de crevettes déclarées par radio pour la pêche commerciale (en kg pour toutes les principales zones statistiques) pour estimer les captures totales d'eulakanes. Les captures accidentelles les plus élevées étaient celles des chaluts à panneaux de la partie centre de la côte où le rapport entre le poids des eulakanes et celui des crevettes était de 0,210. Par conséquent, pour chaque 1000 kg de crevettes, 210 kg (LC 95% = 173 à 251) d'eulakanes étaient capturés. Après correction par la valeur totale des captures (rapports radio), la valeur estimée d'eulakanes capturés dans les zones du centre de la côte s'élève à 90 tonnes. Les captures accidentelles d'eulakanes étaient aussi élevées pour la pêche au chalut à panneaux de la côte ouest de l'île Vancouver, où la valeur estimée s'élève à 52 tonnes. De façon générale, les valeurs estimées des captures accidentelles d'eulakanes étaient inférieures dans les autres zones et négligeables dans le détroit de Géorgie. Les captures accidentelles d'eulakanes par les chaluts à perche étaient inférieures, bien qu'elles ont été estimées à 22 tonnes pour la côte ouest de l'île de Vancouver. Nous concluons par une courte discussion des incidences biologiques de ces taux de capture.

INTRODUCTION

This paper presents a preliminary analysis of bycatch in the 1997 British Columbia shrimp trawl fishery. The analysis is preliminary because the data on fishing effort (duration of fishing time and total tows made) for the 1997 fishery are not yet available. There are, however, urgent concerns about some aspects of bycatch, especially for eulachons *(Thaleichthys pacificus)*. Some management decisions were required prior to the beginning of the 1998 shrimp fishery. Therefore, we used an alternative approach using 'hailed' catch data as an approximation of total shrimp catch.

The main objective is to estimate the approximate size of eulachon bycatch in shrimp trawl fisheries in different areas and by different fishing gears. Details of this fishery, including area-specific quotas and effort are described in Southey et al. (1998). This information on bycatch will be used for planning the 1998 shrimp fishery so even approximate estimates of eulachon bycatch are useful. We provide these estimates, and also provide a very brief discussion on the implications of bycatch. The results also will be used to assist planning of any further bycatch analysis projects.

This paper reports mainly on eulachons, which is a relatively small part of the total data collection that includes information on the incidence of capture of over 100 different fish species and many invertebrate species. We relate the relative abundance of eulachons to shrimp for different areas and different fishing gears. Then we use the hailed estimates of shrimp catches to estimate eulachon catch. We anticipate that these analyses will be revised later, when the effort data are available.

MATERIALS AND METHODS

We use data from two different sources: (1) 'hailed' catch data, from June to December and (2) catch composition data from analyses of shrimp trawl catches from March to October based on an observer program that was implemented in 1997. The hailed estimates of the total shrimp catch are collected routinely in a timely manner to monitor total catch rates in different areas. The hailed catch data are summarized by gear, Statistical Area and month in Appendix Table 1. The data are approximately correct, but as they are based on shipboard estimates (by fishers), they may vary from landed weights collected later at fish plants. The catch analyses data from shipboard observers was collected from different vessels and different areas.

Bycatch data collected in 1997

The rationale for the design of the bycatch program is shown in Appendix 2. A fundamental assumption of the program was that total bycatch was proportional to total fishing effort, although at the onset we recognized that there may be differences between the two types of trawls. The program was designed to place sea-going observers on fishing vessels in all areas and seasons. In practice this is a difficult and complex task because of many uncertainties about future fishing plans and problems establishing contact with sea-going vessels. The operation of the program, which started in March 1997, was conducted by Archipelago Marine Research of Victoria, BC. The observers sampled as much of the catch as possible and identified the target species (shrimp species) and the non-target species with as much detail as time allowed. The 'unit' of data was a trawl 'set'. For each set, data was collected on the catch composition, time and duration of the tow, location (coordinates) of the start and finish of the tow, depth (start and finish), meteorological and sea conditions. This paper presents data only on the catch composition and approximate locations of observer tows. We report only a brief summary of the bycatch of species other than eulachons. For eulachons, we estimate the eulachon bycatch, in catch (g per minute of tow) by month and area. To estimate total eulachon bycatch, we relate the relative eulachon catch to the shrimp catch (see below). For the present analyses we use bycatch data from the period from March 1 to October 31, 1997. There were a few observations made subsequent to this period, but they were not available in time to included in these analyses.

The 1997 fishery - 'hailed' catch by gear, by area and season

Ideally, we would prefer to estimate the total bycatch for eulachon (or any other non-target species) using fishing effort data (i.e. weight captured per unit time of fishing or total time trawled). Such analyses must await the availability of the completed data on fishing effort. As an alternative to fishing effort data, we use the estimates of 'hailed' shrimp catch, that is recorded within the season to monitor total catches. These data are based on a new catch monitoring program that started in June 1997. Therefore the period when data were available was from June 1 to Dec. 31, 1997. The hailed data differentiate among different shrimp species but for these analyses, we pooled all shrimp species simply as 'shrimp'.

Preliminary estimation of bycatch

From the bycatch data collected in the 1997 observer program for each tow, we can estimate the ratio of the eulachon catch (in kg) to the total shrimp catch (in kg). For instance, if the total eulachon catch was 2 kg and the total shrimp catch was 100 kg, the ratio is 2/100 or 0.01. The estimate was calculated for each tow. In the many instances where no eulachons were captured, the ratio was 0. We calculated this ratio for 4 main

areas of the BC coast. For each instance, we assume that the catch of eulachons is proportional to the catch of shrimp. If E_s is defined as the weight (kg) eulachons in the observer-analyzed samples, and Sh_s is the estimate of the total shrimp from the same samples, the ratio of eulachon to shrimp is E_s / Sh_s.

If we assume that the ratio of eulachons to shrimp from the observer samples were similar to the total catch from the fishery (i.e. all vessels from both gears), then

$$E_s / Sh_s = E_c / Sh_c$$

where E_c is the estimated weight of eulachons in the total catch, Sh_c is the weight of shrimp (all landed species) in the samples. Therefore

$$E_c = (E_s / Sh_s)_o \, Sh_c.$$

From the 1997 observer program we can calculate the ratio of eulachons to shrimp (E_s / Sh_s) and the shrimp catch Sh_c can be estimated from the hailed data. We estimated E_s / Sh_s for 4 different locations for each of the gear types. For otter trawls, separate estimates were made for the 'North Coast' (pooled Statistical Areas 3-5), the Central coast (pooled Statistical Areas 10, 101, 108, 110, 111), the 'West Coast' pooled Statistical Areas 21, 23-35, 121, 123-125) and the Strait of Georgia (pooled Statistical Areas 14-19, 28-29). The areas and configuration for beam trawlers was different. Estimates were made for 'Area 12' (Statistical Area 12), the offshore areas of the west coast (pooled Statistical Areas 123-125), the inshore areas of the west coast (pooled Statistical Areas 23-25) and the Strait of Georgia (pooled Statistical Areas 14-19, 28-29). Following procedures explained in Efron (1993), for each area and gear type, we estimated the mean ratio (and 95% confidence limits) based on 500 bootstrap replications (sampled with replacement) from the data from each area. These procedure enabled the estimation of the mean and 95 confidence limits of total eulachon bycatch for each area.

RESULTS

Hailed Data - Catches by Gear type, Month and Area

The hailed catch data, shown by Statistical Area and Month is shown in Table 1a for Beam trawls and Table 1b for Otter trawls. The tables indicate that the two gear types often concentrate in different geographical areas. The figures in bold italics indicate areas that were included in the analyses. The sums of the catches were from June to December, when the catch-monitoring program was implemented, so data from May-June are not included. The June-December period included in the analyses, however, probably accounts for 90-95 % of the total landed catch of areas of high eulachon bycatch in 1997, since most of the offshore grounds were closed to shrimp trawl fishing by the end of October. For both gear

types, the major landings were from May to September. There are major differences in areas between the two main fishing gears. Most of the central coast fishing was conducted by otter trawls, except for some beam trawl fishing in Area 12. Nearly all of the fishing in Georgia Strait is done by beam trawls. Both gears fish the west coast of Vancouver Island, although the beam trawls concentrate more in inshore waters. We cannot yet verify the accuracy of the 1997 hailed data by a comparison of the hailed data with the landed catch data. Such a comparison, however, done for selected areas for the 1995/96 season (not differentiated by gear), indicates that the hail and catch data, summed for different geographical areas, matches very closely (Table 2). Based on this, there are no reasons to expect any major differences between the 1997 hailed catch estimates and the landed catch weights.

Observer Data

For the period from March to October, 1997, a total of 530 tows were examined, 174 from beam trawls and 356 from otter trawls (Table 3). The total weight of all species captured, listed by species (but not by area or season) is shown in Table 4. Eulachons were third most frequently captured species from otter trawls. The distribution of effort, by Statistical Area and month is shown for each Gear type in Tables 5a-5d. For each month and area, and for otter and beam trawls respectively, Tables 5a-5b show the 'mean percent ratio' or ***MPR*** of eulachons to shrimp catches calculated as:
$MPR = 100 \cdot \sum[(\text{eulachon weight}/\text{shrimp weight})]/n$ where ***n*** is the number of tows. Using this computation, for each type of trawl, there are ***n*** estimates of bycatch. This computation is convenient for estimation of ranges of error using bootstrap procedures.

An alternate estimate of bycatch, suggested by a reviewer, is simply the percentage of the sums of the eulachon catch and the shrimp catch, summed over all the tows for each area. This 'percent ratio' or ***PR*** was calculated as:
$PR = 100 \cdot (\sum \text{eulachon weight})/(\sum \text{shrimp weight})$. This procedure provides a single estimate of the ratio of eulachons to shrimp. Variation between the MPR and PR estimates are related to variation among individual tows. The different estimates of eulachon:shrimp rations can be compared by the far right columns of Table 5a and 5c for otter trawlers and Table 5b and 5b for beam trawlers. In general, areas with high bycatch were similar for both estimates (MPR versus PR), and the largest differences occurred when samples sized were low.

For the estimation of eulachon we did not consider temporal variation within the year because the sample sizes were too small for many months. Similarly, there were too many potential geographical groupings to make an estimate for each one. Instead, we pooled the Statistical Areas into 4 broad areas that were slightly different for each gear. This configuration reflected the geographic distribution of

available observer data. For example, we had no observer data from beam trawls in the North Coast, so we were unable to provide an estimate of the bycatch from that area for beam trawls. The geographical distribution of eulachon bycatch, ***from observer data only***, is shown in Fig. 1.

Estimates of eulachon bycatch

The summaries of the total hailed catch for each gear are shown in Table 6. This table also shows the mean estimate of the eulachon:shrimp catch ratios (plus lower and upper 95% confidence limits based on 500 bootstrap replication). The total estimate of eulachon bycatch (with confidence limits) is shown in the right hand columns.

The otter trawl catches in the central coast have the highest bycatch with an estimate 90 tonnes. The west coast of Vancouver Island otter trawl catch was the next highest with an estimated 42 tonnes. In general, the otter trawl bycatch in the North Coast and the Strait of Georgia was very low. In general, beam trawl gear had lower eulachon bycatch, but the combined catch on the west coast of Vancouver Island (inshore and offshore) was over 9 tonnes.

DISCUSSION

• Although the estimates of eulachon bycatch are preliminary, and based in part upon hailed data that are not precise, we nevertheless think that the estimates of total bycatch are roughly accurate. Therefore, we suggest that the main issues regarding eulachon bycatch is not the precision of the estimates. Rather, the issues concern (1) the biological impact of the eulachon bycatch and (2) the likelihood of effective approaches to reduce the bycatch. In the remainder of this paper we provide some brief comments about the potential biological impacts of the bycatch. We do not attempt to provide a thorough discussion of methods for eulachon bycatch reduction but we do provide a brief list of potential approaches for future consideration. This discussion begins with a brief review of salient eulachon distribution and life history.

Overview of eulachon life history

Like salmon, eulachons are anadromous: they spawn in rivers and migrate to 'offshore' grounds where they feed and grow for 2-3 years before they return to spawn. Probably all eulachons die after spawning. Unlike salmon, however, the fidelity of spawning to natal rivers is less certain. It is likely that many return to the same rivers they were born in, particularly with large rivers like the Fraser and Columbia. With smaller rivers, however, there may be more straying. Incomplete results from genetic analyses indicate no

significant differences between adjacent rivers. Other analyses of data on elemental chemical analyses have failed to find consistent differences between rivers. Therefore, at the present time, we cannot identify the origins of the eulachons taken in the bycatch study using genetic or chemical approaches. Based on analyses of a research times series off the west coast of Vancouver Island (Hay et al 1997) it seems that eulachon populations may change distribution between years. Also, some fishers have indicated that the abundance of eulachons in the Central coast in 1997 was unusual, and not seen in previous years. Therefore, the summer distributions of eulachons may change from year to year. The key biological question, however, is whether the bycatch could be taken from a few small stocks. If so, the size of the bycatch may be very large relative to the size of some small runs. For instance, Pedersen et al (1995) estimated the Kitimat River run at only 20 tonnes but acknowledge that this estimate may be conservative, perhaps by a factor of 5.

Presently, we believe that there may be only about 15 eulachon populations spawning in BC (Fig. 2). South of BC, there may only be two populations: one in the Columbia River and the other in the Klamath River. There may be only 3-4 populations spawning in rivers in Southeast Alaska. Therefore there are only a few populations and many have experienced declines in abundance. The causes of the declines are uncertain and there may be a number of explanations including habitat deterioration (Rogers et al. 1990). Probably the fisheries for eulachon are not the cause of the decline because most are very small. Similarly, the bycatch of eulachons in shrimp nets may not be the cause of the decline but the bycatch may represent an obstacle for the recovery of some eulachon populations, especially if the bycatch were taken from some of the smaller populations.

Throughout much of their range, eulachon populations have declined in recent years (Moyle 1994, Hay et al, 1997). The causes of this decline are uncertain. A gradual decline of eulachons, and other anadromous fishes has occurred in California during the last 15 years (Moyle 1994). The decline in the Columbia River has been recent, beginning in 1993. The Fraser River seems to have experienced a gradual decline followed by a sharp drop in availability of eulachons in 1994 (Hay et al 1997). Apparently, eulachons have declined in some central BC coast rivers, although the timing and severity of the declines is uncertain at this time. The eulachon run in the Nass River, however, continues to support an active fishery and may not have experienced the same declines as other rivers to the south. The status of eulachons in Alaskan rivers is neither known, nor documented.

Biological impact of the eulachon bycatch

A key issue concerning bycatch, is the *origin* of the eulachons taken by the gear. Hay et al (1997) speculate that some of the bycatch from the west coast of Vancouver Island may be from the Columbia River. This is based on the following observations: There are no known eulachon spawning areas on any of the rivers on the west coast of Vancouver Island. The Fraser and Columbia Rivers are the largest and closest eulachon populations to the west coast shrimp fishing grounds. Columbia River eulachons spawn mainly in January and

February (Smith and Saalfeld 1955) whereas Fraser River eulachons spawn mainly in April and May (Ricker et al 1954). The west coast shrimp fishery takes eulachons at the same time (April and May) as the main Fraser River spawning run is in progress - when most Fraser River eulachons would be spawning and not be on the west coast. On the other hand, perhaps the eulachons taken at this time are immature Fraser River eulachons, and it is possible that Fraser river eulachons could be taken in the west coast shrimp fishery at other times in the year.

Until recently, the Columbia River eulachon population supported an annual fishery of several thousand tonnes (Anon 1993). The Fraser River run was probably much smaller, but in the 1950's, the annual commercial fishery took several hundred tonnes per year (Ricker et al 1954). With spawning run sizes in the Fraser and Columbia rivers of many hundreds or thousands of tonnes, a bycatch of 40 tonnes (the 1997 west coast estimate) or 90 tonnes (the 1997 Central coast estimate), while not desirable, would be a smaller concern than if the spawning runs of eulachons were smaller - and both the Fraser and Columbia runs appear to be low at the present time. The Central coast bycatch of 90 tonnes is a particular concern because it is possible that some of these eulachons originate from relatively small eulachon populations spawning in Central coast rivers (Fig. 2). Although we do not know the size of these runs, it is reasonable to expect that they are much smaller than the Columbia and Fraser River runs.

Approaches to bycatch reduction of eulachons

There are some potential approaches for the reduction of bycatch. ***Technological approaches*** include the use of deflection devices (i.e. grids) and increasing net mesh size to allow fish to pass through nets. While such devices may be useful for reduction of incidental catch of many species, their effectiveness for eulachons is uncertain. More effective and simpler approaches include the reduction of the height of the headrope and net design that allows the headrope to follow the groundline. The relatively low rise and smaller size of most beam trawl nets, compared to the larger and taller otter trawl nets, may be one reason for the lower eulachon catch in beam trawls. The slower towing rate of beam trawls is likely another.

Potential ***biological approaches*** might include determining the times and places when eulachons and shrimps segregate. For instance, eulachons do not occur in some areas, such as the Strait of Georgia. It is conceivable, but improbable, that there may be predicable times or places or circumstances on the west coast of Vancouver Island when shrimps and eulachons separate. We will examine the bycatch data to look for such possible occurrences, but based on preliminary analyses, we are not optimistic for such a biological solution. Alternately, some insight may be gained by learning more about the offshore biology of eulachons, and their behavioural reaction to trawls. More research in these areas might be useful, but it is expensive and does not promise a solution. There are several potential ***management options*** to reduce bycatch that can be imposed at different geographical levels or by gear-type. For instance, a maximum allowable bycatch could be

set for an area. Once reached, then the fishery would end, even if the quota for the target species were not met.

The purpose of this paper, however, was not to recommend any particular course of action - and there probably are some options that we have not listed here. Rather, we reiterate that our objective was to describe the scale of the eulachon bycatch in the shrimp fishery, which is estimated at over 160 tonnes for all areas. Clearly this bycatch is large relative to the probable population sizes in small rivers and it is substantially larger that the entire Fraser River quota, which is only 20 tonnes. Some attention to this issue is required and we anticipate that the information in this paper will be used as a basis for further discussion for remedial action.

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REFERENCES

Anonymous. 1993. Status Report - Columbia River fish runs and fisheries, 1938-1992. Joint Publication of the Oregon Dept. of Fish and Wildlife and the Washington State Dept. of Fisheries. 257p.

Efron, B. 1993. An introduction to the bootstrap. Chapman & Hall. New York. 436 pp.

Hay, D.E., J. Boutillier, M. Joyce and G. Langford. 1997. The eulachon (*Thaleichthys pacificus*) as an indicator species in the North Pacific. Wakefield Fisheries Symposium. Alaska Sea Grant College Program 97-01: p 509-530.

Moyle, P. 1994. The decline of anadromous fishes in California. Conservation Biology 8: 869-870.

Pedersen, R.V.K., U.N. Orr and D.E. Hay. 1993. Distribution and preliminary stock assessment (1995) of the eulachon, *Thaleichthys pacificus*, in the lower Kitimat River, British Columbia. Can. Man. Rep. Fish. Aquatic Sci. 2330: 20p.

Ricker, W.E., D.F. Manzer and E.A. Neave. 1954. The Fraser River eulachon fishery, 1941-1953. Fish. Res. Bd. Canada. MS Rept. Biol. Sta., No. 583, 35 p.

Rogers, I.H., Birtwell, I.K. and G.M. Kruzynski. 1990. The Pacific eulachon (*Thaleichthys pacificus*) as a pollution indicator organism in the Fraser River estuary, Vancouver British Columbia. Science of the total Environment. 97/98. 713-727.

Smith, W.E. and R.W. Saalfeld. 1955. Studies on Columbia River smelt, *Thaleichthys pacificus* (Richardson). Fish. Res. Papers. Wash. Dept. Fisheries 1: 3-26.

Southey, K., R. Harbo and J. Boutillier. 1998. Shrimp trawl fishery - 1997/98. PSARC Fishery Update. January 1988.

Fig. 1. The distribution of eulachon bycatch shown for otter trawls and beam trawls from the 1997 observer data. The areas of the symbols (circles for otter trawls and diamonds for beam trawls) are proportional to the size of the bycatch. In most areas the symbols overlap.

Fig. 2. The distribution of eulachon populations in British Columbia, including the Columbia River in Washington state.

Table 1a. Beam trawls. Hailed estimates of total tonnes of shrimp (all species) caught by beam trawls, shown by gear type, month and Statistical area. The numbers in large, bold italics indicate the data used for analyses of eulachon bycatch.

StatArea	June	July	Aug	Sept	Oct	Nov	Dec	All
North Coast								
2	--	--	--	--	--	--	--	--
3	1.2698	3.5619	2.6617	4.5238	2.3265	--	--	14.3438
4	0.2494	1.8367	5.3379	11.4971	3.8027	7.3968	3.6100	33.7306
5	--	--	--	--	--	--	0.0907	0.0907
Central Coast								
(inshore)								
6	--	0.0000	--	--	--	--	--	0.0000
7	--	--	--	1.0930	--	--	--	1.0930
8	--	--	--	--	1.4059	--	2.2676	3.6735
9	--	--	--	--	--	--	--	--
10	--	--	--	--	2.8571	5.4422	--	8.2993
12	***17.3039***	***41.5805***	***2.6077***	***77.8853***	***4.9433***	***0.3628***	--	***144.6834***
(offshore)								
101	--	--	--	--	--	--	--	--
108	--	--	--	--	--	--	--	--
110	--	--	--	--	--	--	--	--
111	--	--	--	--	--	--	--	--
121	--	--	--	--	--	--	--	--
Strait of Georgia								
13	--	***0.0000***	***0.4036***	***3.5193***	***5.9819***	***4.4399***	***2.7755***	***17.1202***
14	***0.8617***	***6.7234***	***3.9438***	***6.5601***	***4.6757***	***5.4295***	***3.5401***	***31.7342***
15	***0.2948***	***4.4580***	***4.7524***	***6.8662***	***6.1723***	***11.0789***	***6.5238***	***40.1465***
16	***1.0884***	***0.4762***	***1.1338***	***1.2245***	***0.6667***	***1.8780***	***1.9297***	***8.3973***
17	***0.7320***	***0.1102***	***0.0454***	***1.3333***	***2.1084***	***8.0422***	***4.6363***	***17.0077***
18	***2.5143***	***1.7719***	***1.2322***	***11.6721***	***13.1356***	***16.9447***	***9.4766***	***56.7474***
19	***0.3175***	***0.9615***	***2.8571***	***0.3265***	***1.8481***	***7.6095***	--	***13.9202***
20	--	--	--	***0.1043***	--	--	--	***0.1043***
28	***3.3229***	***3.8553***	***5.5601***	***15.3605***	***8.3628***	***1.6190***	--	***38.0807***
29	***4.0440***	***3.9020***	***3.8277***	***6.0068***	***4.1664***	***2.0295***	***0.9070***	***24.8834***
West Coast Vancouver Island								
(inshore)								
21	--	--	--	--	--	--	--	--
23	***27.2562***	***66.2222***	***23.4422***	***63.2948***	***65.9252***	***19.4195***	--	***265.5601***
24	--	--	--	--	--	***0.1673***	***0.0136***	***0.1810***
25	--	--	--	--	***0.1134***	***0.3247***	--	***0.4381***
27	0.0204	--	--	--	--	--	--	0.0204
(offshore)								
123	***29.1837***	***101.8367***	***61.3107***	***102.1043***	***28.7247***	--	--	***323.1601***
124	--	***6.2132***	***9.1669***	--	--	--	--	***15.3800***
125	--	--	***0.8889***	--	--	--	--	***0.8889***
126	--	--	--	--	--	--	--	--
127	--	--	--	--	--	--	--	--
All	***88.4590***	***243.5098***	***129.1719***	***313.3719***	***157.2168***	***92.1846***	***35.7710***	***1060.0000***

Table 1b. Otter trawls. Hailed estimates of total tonnes of shrimp (all species) caught by otter trawls, shown by gear type, month and Statistical area. The numbers in large, bold italics indicate the data used for analyses of eulachon bycatch.

StatArea	June	July	Aug	Sept	Oct	Nov	Dec	All
North Coast								
2	--	--	--	--	1.5873	--	--	1.5873
3	--	--	*5.4422*	--	--	--	--	*5.4422*
4	--	--	--	--	--	*1.0857*	*1.7252*	*2.8109*
5	--	--	--	*3.7188*	--	*9.5238*	--	*13.2426*
Central Coast								
(inshore)								
6	--	--	6.8027	1.6961	1.3605	0.0000	3.7642	13.6236
7	10.4308	34.9206	4.9887	9.0703	0.0363	--	--	59.4467
8	--	--	--	--	--	--	--	--
9	--	1.1338	4.5351	--	--	--	--	5.6689
10	--	*20.8617*	*13.1519*	*5.4422*	--	--	--	*39.4558*
12	--	--	--	0.6803	--	--	--	0.6803
(offshore)								
101	--	--	--	*2.2676*	--	--	--	*2.2676*
108	*82.4036*	*171.6780*	*70.7029*	*38.1406*	--	--	--	*362.9252*
110	--	*6.4172*	--	*14.5125*	--	--	--	*20.9297*
111	--	--	*4.9887*	--	--	--	--	*4.9887*
121	--	*4.5351*	--	--	--	--	--	*4.5351*
Strait of Georgia								
14	*0.0045*	*0.2358*	*0.4535*	*2.9660*	*3.1202*	*1.9615*	*1.6417*	*10.3832*
15	--	--	--	--	--	--	--	--
16	--	--	--	--	--	--	--	--
17	--	--	--	--	*0.0454*	--	--	*0.0454*
18	--	--	--	--	--	*0.2721*	*0.1134*	*0.3855*
28	--	--	--	--	*0.3492*	--	--	*0.3492*
29	--	--	--	*0.0068*	--	--	--	*0.0068*
West Coast Vancouver Island								
(inshore)								
21	--	*3.6281*	--	--	--	--	--	*3.6281*
23	*2.7211*	--	--	--	*29.5011*	*10.2041*	--	*42.4263*
24	--	--	--	*0.0907*	--	--	--	*0.0907*
25	--	--	--	--	--	*4.5351*	--	*4.5351*
(offshore)								
123	*41.9501*	*142.4036*	*73.8322*	*101.5079*	*33.5828*	--	--	*393.2766*
124	*19.7732*	*115.4649*	*100.0000*	*48.2585*	*9.5238*	--	--	*293.0204*
125	--	*5.8957*	--	--	--	--	--	*5.8957*
126	--	5.4422	--	--	--	--	--	5.4422
127	11.7914	0.0000	9.5238	1.8141	--	--	--	23.1293
All	*169.0748*	*512.6168*	*294.4218*	*230.1723*	*79.1066*	*27.5823*	*7.2444*	*1320.0000*

Table 2. Comparison of selected catches estimated by "Skippers" versus the weighed catch at the plants, in 1995-96, in areas that correspond to the 1997 bycatch survey. These estimated weights (in pounds) represents the sums of many individual catches. The locations represent statistical areas, or groups of statistical areas, designated as either 'IN' for inshore and 'OFF' for offshore areas. PRD+s and PRD-s is the Prince Rupert District (with and without sidestripe shrimps). QSSND is Queen Charlotte Sound. Georgia Strait Estimates are not included. The estimated and landed weights are closely correlated (r^2 >99%).

	Skippers' Estimated Weights	Plant Weights
North Coast		
3 IN	34274	34528
PRD+S	102208	102196
PRD-S	150275	178119
5 OFF	5303	8379
Central Coast		
6 IN	18878	21496
7 IN	5688	4562
8 IN	6721	4501
9 IN	25274	25421
10 IN	20712	19951
QSSND	1354746	1264227
West Coast Vancouver Island		
23 IN	384449	363156
23 OFF	1886275	1839227
124 OFF	962339	910102

Table 3. Summary of the numbers of sets examined for bycatch shown by Statistical Area and gear. The numbers are approximate.

Stat. Area	OTTER TRAWL	BEAM TRAWL	All
3	2	0	2
4	88	0	88
10	37	0	37
12	0	25	25
14	13	17	30
15	0	18	18
17	3	0	3
18	0	11	11
19	0	15	15
23	17	32	49
28	0	9	9
29	0	1	1
107	2	0	2
108	96	0	96
110	1	0	1
123	27	43	72
124	54	3	57
125	16	0	16
All	356	174	530

Table 4. List of all species taken in the observer samples, showing the common and scientific names. The list is sorted with the most frequently captured species (from both gear types combined) at the top. The percentage of catch (estimated as 100*[species weight]/[total catch weight]) is estimated for both gear types and for the combined catch (both). The underlined common names indicate the main target species. The asterisks preceding some common names indicate species that may survive capture and sorting - and therefore represent a different category of bycatch than species which do not survive capture. This categorization is subject to further review and analyses. The top 20 species (listed above the dotted line) account for approximately 98% and 95 % of the Otter Trawl and Beam Trawl catches, respectively. There are about 125 species (or categories) listed in the table. The accuracy of the identifications some of the least common species, especially those ranked in the last 50 in terms of abundance, could be in error.

		Catch (weight in kg)			Percent of catch		
Common Name	*Scientific Name*	Otter	Beam	Both	Otter	Beam	Both
PINK SHRIMP (SMOOTH)	*Pandalus jordani*	61.7000	11.4000	73.0000	71.6471	49.8606	67.0461
SIDESTRIPE SHRIMP	*Pandalopsis dispar*	6.0668	2.5951	8.6618	7.0448	11.3501	7.9554
EULACHON	*Thaleichthys pacificus*	7.3904	0.2700	7.6604	8.5818	1.1810	7.0356
PINK SHRIMP	*Pandalus borealis*	1.8522	1.8786	3.7308	2.1508	8.2165	3.4265
*SPOTTED RATFISH	*Hydrolagus colliei*	0.8865	1.1847	2.0712	1.0294	5.1817	1.9023
EELPOUTS	*Zoarcidae (family)*	1.6258	0.3559	1.9817	1.8879	1.5566	1.8201
ARROWTOOTH FLOUNDER	*Atheresthes stomias*	1.0087	0.1473	1.1560	1.1713	0.6444	1.0617
PACIFIC HAKE	*Merluccius productus*	0.4933	0.4603	0.9536	0.5728	2.0134	0.8758
*SPINY DOGFISH	*Squalus acanthias*	0.0736	0.8689	0.9426	0.0855	3.8005	0.8657
FLATHEAD SOLE	*Hippoglossoides elassodon*	0.6810	0.2199	0.9009	0.7908	0.9616	0.8274
REX SOLE	*Errex zachirus*	0.5850	0.2045	0.7894	0.6793	0.8943	0.7250
ENGLISH SOLE	*Pleuronectes vetulus*	0.2855	0.2646	0.5501	0.3316	1.1572	0.5053
SLENDER SOLE	*Eopsetta exilis*	0.3930	0.1117	0.5048	0.4564	0.4886	0.4636
*BIG SKATE	*Raja binoculata*	0.4572	0.0247	0.4820	0.5309	0.1082	0.4427
WALLEYE POLLOCK	*Therugra chalcogramma*	0.2098	0.1817	0.3915	0.2436	0.7948	0.3596
*LONGNOSE SKATE	*Raja rhina*	0.0614	0.3262	0.3876	0.0713	1.4266	0.3559
PRAWN	*Pandalus platyceros*	0.1151	0.2544	0.3694	0.1336	1.1125	0.3393
COON STRIPE SHRIMP	*Pandalus danae*	0.0057	0.3094	0.3151	0.0066	1.3534	0.2894
DOVER SOLE	*Microstomus pacificus*	0.2031	0.1001	0.3032	0.2359	0.4376	0.2785
PACIFIC SANDDAB	*Citharichthys sordidus*	0.0501	0.2483	0.2984	0.0582	1.0862	0.2741
SHINER PERCH	*Cymatogaster aggregata*	0.2033	0.0348	0.2381	0.2361	0.1522	0.2187
SCULPINS	*Cottidae (family)*	0.0599	0.1428	0.2028	0.0696	0.6247	0.1862
PACIFIC HERRING	*Clupea pallasi*	0.1443	0.0466	0.1909	0.1676	0.2039	0.1754
UNKNOWN FISH	*Unknown fish*	0.0478	0.1230	0.1707	0.0555	0.5378	0.1568
PLAINFIN MIDSHIPMAN	*Porichthys notatus*	0.0226	0.1351	0.1578	0.0263	0.5910	0.1449
DUNGENESS CRAB	*Cancer magister*	0.1529	0.0041	0.1569	0.1775	0.0179	0.1441
HUMPBACK SHRIMP	*Pandalus hypsinotus*	0.0462	0.0916	0.1378	0.0537	0.4005	0.1266
LONGFIN BATFISH	*Platax teira*	0.1185	0.0111	0.1297	0.1376	0.0487	0.1191
COPPER ROCKFISH	*Sebastes caurinus*	0.1234	0.0007	0.1241	0.1433	0.0031	0.1140
PACIFIC HALIBUT	*Hippoglossus stenolepis*	0.1152	•	0.1152	0.1338	•	0.1058
PACIFIC OCEAN PERCH	*Sebastes alutus*	0.0916	0.0003	0.0919	0.1064	0.0011	0.0844
SEGMENTED WORMS	*Phylum annelida*	•	0.0907	0.0907	•	0.3968	0.0833
SABLEFISH	*Anoplopoma fimbria*	0.0762	0.0027	0.0789	0.0885	0.0116	0.0724

Common Name	Scientific Name	Catch (weight in kg)			Percent of catch			(continued)
		Otter	Beam	Both	Otter	Beam	Both	
SEA CUCUMBERS	*Holothuroidea (class)*	0.0742	*	0.0742	0.0861	*	0.0681	
SEA URCHINS	*Echinacea (superorder)*	0.0378	0.0340	0.0718	0.0439	0.1488	0.0660	
SQUAT SQUID	*Rossia pacifica*	0.0480	0.0209	0.0689	0.0558	0.0914	0.0633	
PACIFIC COD	*Gadus macrocephalus*	0.0282	0.0394	0.0676	0.0327	0.1724	0.0621	
""	*Crangon spp*	0.0126	0.0479	0.0605	0.0146	0.2096	0.0556	
YELLOWMOUTH ROCKFISH	*Sebastes reedi*	0.0526	*	0.0526	0.0611	*	0.0483	
SQUID	*Teuthoidea (order)*	0.0360	0.0134	0.0494	0.0418	0.0587	0.0454	
SHRIMP	*Nantantia (order)*	0.0195	0.0292	0.0487	0.0227	0.1275	0.0447	
REDSTRIPE ROCKFISH	*Sebastes proriger*	0.0436	0.0030	0.0466	0.0507	0.0129	0.0428	
PETRALE SOLE	*Eopsetta jordani*	0.0204	0.0216	0.0420	0.0237	0.0943	0.0385	
POACHERS	*Agonidae (family)*	0.0150	0.0245	0.0394	0.0174	0.1070	0.0362	
SPONGES	*Phylum porifera*	0.0363	*	0.0363	0.0421	*	0.0333	
YELLOWTAIL ROCKFISH	*Sebastes flavidus*	0.0282	0.0071	0.0353	0.0327	0.0311	0.0324	
GREENSTRIPED ROCKFISH	*Sebastes elongatus*	0.0127	0.0221	0.0348	0.0147	0.0967	0.0320	
ROCK SOLE	*Pleuronectes bilineatus*	0.0159	0.0186	0.0345	0.0184	0.0813	0.0317	
DARKBLOTCHED ROCKFISH	*Sebastes crameri*	0.0325	0.0020	0.0344	0.0377	0.0085	0.0316	
QUILLBACK ROCKFISH	*Sebastes maliger*	0.0054	0.0193	0.0247	0.0063	0.0844	0.0227	
ANEMONE	*Actiniaria (order)*	0.0179	0.0068	0.0247	0.0207	0.0298	0.0227	
OARFISH	*Regalecus glesne*	0.0014	0.0227	0.0240	0.0016	0.0992	0.0221	
SHORTRAKER ROCKFISH	*Sebastes borealis*	0.0236	*	0.0236	0.0274	*	0.0217	
STARFISH	*Asteroidea (class)*	0.0204	0.0018	0.0222	0.0237	0.0079	0.0204	
CHINOOK SALMON	*Oncorhynchus tshawytscha*	*	0.0218	0.0218	*	0.0952	0.0200	
SMELTS	*Osmeridae (family)*	0.0176	0.0041	0.0216	0.0204	0.0178	0.0199	
SHORTSPINE THORNYHEAD	*Sebastolobus alascanus*	0.0142	0.0073	0.0214	0.0164	0.0317	0.0197	
OCTOPUS	*Octopoda (order)*	0.0029	0.0155	0.0184	0.0034	0.0677	0.0169	
ROUGHEYE ROCKFISH	*Sebastes aleutianus*	0.0157	*	0.0157	0.0182	*	0.0144	
LINGCOD	*Ophiodon elongatus*	0.0077	0.0078	0.0155	0.0090	0.0341	0.0142	
SPLITNOSE ROCKFISH	*Sebastes diploproa*	0.0053	0.0098	0.0151	0.0061	0.0428	0.0138	
PACIFIC SANDFISH	*Trichodon trichodon*	0.0141	*	0.0141	0.0163	*	0.0129	
STARRY FLOUNDER	*Platichthys stellatus*	0.0122	*	0.0122	0.0142	*	0.0112	
SQUAT LOBSTER	*Munida quadrispina*	0.0018	0.0103	0.0121	0.0020	0.0451	0.0111	
HEART URCHINS	*Atelostomata (superorder)*	0.0112	*	0.0112	0.0130	*	0.0103	
PACIFIC TOMCOD	*Microgadus proximus*	*	0.0098	0.0098	*	0.0428	0.0090	
REDBANDED ROCKFISH	*Sebastes babcocki*	0.0091	0.0005	0.0096	0.0106	0.0020	0.0088	
TANNER CRABS	*Chionoecetes spp*	0.0091	*	0.0091	0.0105	*	0.0083	
OPAL SQUID	*Loligo opalescens*	0.0080	0.0010	0.0090	0.0093	0.0044	0.0083	
SCORPIONFISHES	*Scorpaenidae (family)*	0.0047	0.0028	0.0075	0.0055	0.0121	0.0069	
PACIFIC SARDINE	*Sardinops sagax*	0.0068	*	0.0068	0.0079	*	0.0062	
SAND SOLE	*Psettichthys melanostictus*	0.0061	0.0005	0.0066	0.0071	0.0022	0.0061	
SKATES	*Rajidae (family)*	0.0041	0.0009	0.0050	0.0048	0.0040	0.0046	
CORMORANTS	*Family phalacrocoracidae*	*	0.0050	0.0050	*	0.0218	0.0046	
""	*Cephalopoda (family)*	0.0025	0.0022	0.0047	0.0029	0.0098	0.0044	

Common Name	Scientific Name	Catch (weight in kg) Otter	Beam	Both	Percent of catch Otter	Beam	Both
PINK SHRIMP (FLEXED)	*Pandalus goniurus*	0.0008	0.0032	0.0039	0.0009	0.0139	0.0036
SEA PENS	*Pennatulacea (order)*	0.0036	*	0.0036	0.0042	*	0.0033
SMOOTHHEAD SCULPIN	*Artedius lateralis*	0.0032	*	0.0032	0.0037	*	0.0029
SHARPCHIN ROCKFISH	*Sebastes zacentrus*	0.0019	0.0007	0.0026	0.0022	0.0031	0.0024
""	*Ophiuroidea (class)*	0.0025	*	0.0025	0.0028	*	0.0023
WHITEBAIT SMELT	*Allosmerus elongatus*	*	0.0024	0.0024	*	0.0103	0.0022
""	*Repiantia (suborder)*	*	0.0023	0.0023	*	0.0099	0.0021
STURGEON POACHER	*Podathecus acipenserinus*	0.0022	*	0.0022	0.0026	*	0.0021
GREENLINGS	*Hexagrammidae (family)*	0.0018	0.0003	0.0021	0.0021	0.0011	0.0019
HYDROID	*Hydrozoa (class)*	0.0019	*	0.0019	0.0022	*	0.0018
STONY CORALS	*Madreporia (order)*	0.0005	0.0014	0.0019	0.0006	0.0060	0.0017
SPECKLED SANDDAB	*Citharichthys stigmaeus*	*	0.0018	0.0018	*	0.0079	0.0017
YELLOWEYE ROCKFISH	*Sebastes ruberrimus*	*	0.0018	0.0018	*	0.0079	0.0017
PILE PERCH	*Rhacochilus vacca*	0.0016	*	0.0016	0.0019	*	0.0015
PRICKLEBACKS	*Stichaeidae (family)*	*	0.0015	0.0015	*	0.0066	0.0014
GUNNELS	*Pholidae (family)*	*	0.0015	0.0015	*	0.0066	0.0014
JACK MACKEREL	*Trachurus symmetricus*	0.0014	*	0.0014	0.0016	*	0.0012
BIVALVES	*Bivalvia (class)*	0.0014	*	0.0014	0.0016	*	0.0012
GRENADIERS	*Macrouridae (family)*	*	0.0014	0.0014	*	0.0060	0.0012
BOCACCIO	*Sebastes paucispinis*	0.0005	0.0007	0.0012	0.0006	0.0031	0.0011
NORTHERN ANCHOVY	*Engraulis mordax mordax*	0.0005	0.0008	0.0012	0.0005	0.0033	0.0011
BLACK HAGFISH	*Eptatretus deani*	0.0008	0.0003	0.0010	0.0009	0.0011	0.0009
""	*Invertebrates*	0.0008	0.0003	0.0010	0.0009	0.0011	0.0009
THREESPINE STICKLEBACK	*Gasterosteus aculeatus*	0.0009	*	0.0009	0.0011	*	0.0008
CANCER CRABS	*Cancridae (family)*	*	0.0009	0.0009	*	0.0040	0.0008
WIDOW ROCKFISH	*Sebastes entomelas*	0.0009	*	0.0009	0.0011	*	0.0008
""	*Phylum arthropoda*	0.0008	*	0.0008	0.0009	*	0.0007
SAND DOLLARS	*Gnathostomata (superorder)*	0.0008	*	0.0008	0.0009	*	0.0007
SCALLOP	*Pectinidae (family)*	*	0.0005	0.0005	*	0.0022	0.0005
GASTROPODS	*Gastropoda (class)*	0.0005	*	0.0005	0.0006	*	0.0005
SEASLUGS	*Nudibranchiata (suborder)*	0.0005	*	0.0005	0.0006	*	0.0005
HARLEQUIN ROCKFISH	*Sebastes variegatus*	0.0005	*	0.0005	0.0006	*	0.0005
LUMPFISHES & SNAILFISHES	*Cyclopteridae (family)*	0.0005	*	0.0005	0.0006	*	0.0005
TUBE WORMS	*Sedentaria (subclass)*	0.0005	*	0.0005	0.0006	*	0.0005
""	*Anomura (section)*	0.0005	*	0.0005	0.0006	*	0.0005
CRUSTACEANS	*Crustacea (class)*	0.0005	*	0.0005	0.0006	*	0.0005
PINK SALMON	*Oncorhynchus gorbuscha*	0.0005	*	0.0005	0.0005	*	0.0004
RED IRISH LORD	*Hemilepidotus hemilepidotus*	0.0005	*	0.0005	0.0005	*	0.0004
BOX CRABS	*Lopholithodes spp*	*	0.0005	0.0005	*	0.0020	0.0004
""	*Chionoecetes bairdi*	0.0005	*	0.0005	0.0005	*	0.0004
CANARY ROCKFISH	*Sebastes pinniger*	*	0.0005	0.0005	*	0.0020	0.0004
SPIDER CRABS	*Oxyrhyncha (superfamily)*	*	0.0005	0.0005	*	0.0020	0.0004

(continued)

Common Name	Scientific Name	Catch (weight in kg)			Percent of catch			(continued)
		Otter	Beam	Both	Otter	Beam	Both	
GIANT SQUID	*Moroteuthis robusta*	0.0003	*	0.0003	0.0003	*	0.0002	
RED SQUID (SCHOOLMASTer)	*Berryteuthis magister*	0.0003	*	0.0003	0.0003	*0.0002		
QUILLFISH	*Ptilichthyidae (family)*	0.0003	*	0.0003	0.0003	*	0.0002	
FISH EGGS	*Fish eggs*	0.0003	*	0.0003	0.0003	*	0.0002	
PYGMY POACHER	*Odontopyxis trispinosa*	*	0.0003	0.0003	*	0.0011	0.0002	
RAGFISHES	*Icosteidae (family)*	0.0003	*	0.0003	0.0003	*	0.0002	
CHUB MACKEREL	*Scomber japonicus*	0.0003	*	0.0003	0.0003	*	0.0002	
CHITONS	*Polyplacophora (subclass)*	0.0003	*	0.0003	0.0003	*	0.0002	
"JUNK"		*	0.3175	0.3175	*	1.3887	0.2916	
NO FISH IN SAMPLE		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	

Table 5a. Otter trawls. Summary of the ratios of eulachon catch to total shrimp catch in otter trawls - based on ***arithmetic*** means. For each Statistical Area, the numbers in the top row indicate the relative weight of eulachons captured per unit weight of shrimp, and the lower row indicates the numbers of samples. For instance, 2.5 would indicate that for every 100 kg of shrimp, 2.5 kg of eulachons were captured.

STAT	Mar	April	May	July	Aug	Sept	Oct	All
3	--	--	--	--	0.000	--	--	0.000
	0	0	0	0	2	0	0	2
4	--	--	2.720	--	1.245	--	--	1.429
	0	0	11	0	77	0	0	88
10	--	--	--	--	19.381	14.502	--	15.425
	0	0	0	0	7	30	0	37
14	--	--	0.320	--	--	--	0.000	0.148
	0	0	6	0	0	0	7	13
17	--	--	--	0.000	--	--	--	0.000
	0	0	0	3	0	0	0	3
23	--	--	--	--	--	--	7.284	7.284
	0	0	0	0	0	0	17	17
107	--	--	--	31.067	--	0.000	--	15.534
	0	0	0	1	0	1	0	2
108	--	--	--	24.524	21.321	0.000	--	23.179
	0	0	0	69	25	2	0	96
110	--	--	--	--	--	27.347	--	27.347
	0	0	0	0	0	1	0	1
123	--	5.243	--	4.223	--	4.322	0.256	4.137
	0	5	0	15	0	5	2	27
124	--	39.366	--	0.450	1.359	--	0.750	5.268
	0	6	0	18	29	0	1	54
125	2.119	26.203	--	--	--	--	--	17.171
	6	10	0	0	0	0	0	16
All	2.119	24.973	1.873	16.931	5.743	12.410	4.633	10.609
	6	21	17	106	140	39	27	356

Table 5b. Beam trawls. Summary of the ratios of eulachon catch to total shrimp catch in otter trawls - based on ***arithmetic*** means. For each Statistical Area, the numbers in the top row indicate the relative weight of eulachons captured per unit weight of shrimp, and the lower row indicates the numbers of samples. For instance, 2.5 would indicate that for every 100 kg of shrimp, 2.5 kg of eulachons were captured.

STAT	Mar	April	May	July	Aug	Sept	Oct	All
12	--	--	--	--	0.000	0.016	--	0.013
	0	0	0	0	4	21	0	25
14	--	--	0.074	--	--	--	0.000	0.044
	0	0	10	0	0	0	7	17
15	--	--	--	0.000	0.000	--	--	0.000
	0	0	0	12	6	0	0	18
18	--	0.000	0.000	--	--	--	--	0.000
	0	5	6	0	0	0	0	11
19	--	--	0.000	--	0.000	--	--	0.000
	0	0	2	0	13	0	0	15
23	--	--	--	0.000	--	2.378	1.184	1.632
	0	0	0	1	0	13	18	32
28	--	--	--	--	--	0.000	0.000	0.000
	0	0	0	0	0	1	8	9
29	--	--	--	--	--	--	0.000	0.000
	0	0	0	0	0	0	1	1
123	--	--	0.539	13.660	2.549	0.551	0.000	5.598
	0	0	13	16	4	9	1	43
124	--	--	--	0.206	--	--	--	0.206
	0	0	0	3	0	0	0	3
All	--	0.000	0.250	6.849	0.378	0.823	0.609	1.693
	0	5	31	32	27	44	35	174

Table 5c. Otter trawls. Sums of catch weights of eulachon and shrimps by Statistical Area and month. For each month and area with a detectable bycatch, the top row (bold italics) indicates the percentage of eulachons in the bycatch [calculated as 100 ∑(eulachon t)/(∑shrimp wt)]. The second and third rows shows the eulachon and shrimp catch weight in kg. The bottom row is the numbers of tows.

STAT	Mar	Apr§	May	July	Aug	Sept	Oct	All
3	--	--	--	--	0.000	--	--	0.000
	--	--	--	--	53.86	--	--	53.86
	0	0	0	0	2	0	0	2
			0.87		***0.88***			***0.88***
4	--	--	6.350	--	44.600	--	--	50.950
	--	--	728.05	--	5067.53	--	--	5795.58
	0	0	11	0	77	0	0	88
					17.07	***13.66***		***14.65***
10	--	--	--	--	445.890	360.020	--	1305.910
	--	--	--	--	2613.18	6298.22	--	8911.40
	0	0	0	0	7	30	0	37
			0.30				***0.00***	***0.10***
14	--	--	1.350	--	--	--	0.000	1.350
	--	--	449.98	--	--	--	869.64	1319.62
	0	0	6	0	0	0	7	13
				0.00				***0.00***
17	--	--	--	0.000	--	--	--	0.000
	--	--	--	22.07	--	--	--	22.07
	0	0	0	3	0	0	0	3
							7.03	***7.03***
23	--	--	--	--	--	--	207.760	207.760
	--	--	--	--	--	--	2952.89	2952.89
	0	0	0	0	0	0	17	17
				31.07		***0.00***		***28.71***
107	--	--	--	86.180	--	0.000	--	86.180
	--	--	--	277.40	--	22.68	--	300.08
	0	0	0	1	0	1	0	2
				16.11	***28.35***	***0.00***		***17.20***
108	--	--	--	3690.470	1551.310	0.000	--	5241.780
	--	--	--	22902.27	7533.80	34.02	--	30470.09
	0	0	0	69	25	2	0	96
						27.34		***27.34***
110	--	--	--	--	--	89.810	--	89.810
	--	--	--	--	--	328.41	--	328.41
	0	0	0	0	0	1	0	1
		8.26		***3.62***		***5.90***	***0.24***	***4.22***
123	--	31.300	--	110.210	--	88.000	1.360	230.870
	--	378.75	--	3042.30	--	1498.97	553.84	5473.86
	0	5	0	15	0	5	2	27
		9.65		***0.43***	***18.24***		***0.75***	***18.35***
124	--	28.120	--	16.860	84.890	--	1.360	131.230
	--	291.21	--	3866.98	8288.29	--	181.44	12627.92
	0	6	0	18	29	0	1	54
	3.00	***3.10***						***3.01***
125	14.060	29.040	--	--	--	--	--	43.100
	467.21	935.78	--	--	--	--	--	1402.99
	6	10	0	0	0	0	0	16
	3.00	***5.55***	***0.65***	***12.96***	***9.03***	***12.69***	***4.61***	***10.60***
All	14.060	88.460	7.700	3903.720	2126.690	1037.830	210.480	7388.940
	467.21	1605.74	1178.03	30111.02	23556.66	8182.30	4557.81	69658.77
	6	21	17	106	140	39	27	356

Table 5d. Beam trawls. Sums of catch weights of eulachon and shrimps by Statistical Area. For each month and area with a detectable bycatch, the top row (bold italics) indicates the percentage of eulachons in the bycatch [calculated as 100 Σ(eulachon t)/(Σshrimp wt)]. The second and third rows shows the eulachon and shrimp catch weight in kg. The bottom row is the numbers of tows.

STAT	Mar	April	May	July	Aug	Sept	Oct	All
					0.00	***0.02***		***0.01***
12	--	--	--	--	0.000	0.450	--	0.450
	--	--	--	--	765.66	2238.98	--	3004.64
	0	0	0	0	4	21	0	25
			0.14				***0.00***	***0.11***
14	--	--	0.900	--	--	--	0.000	0.900
	--	--	612.79	--	--	--	183.27	796.06
	0	0	10	0	0	0	7	17
				0.00	***0.00***			***0.00***
15	--	--	--	0.000	0.000	--	--	0.000
	--	--	--	665.25	404.15	--	--	1069.40
	0	0	0	12	6	0	0	18
		0.00	***0.00***					***0.00***
18	--	0.000	0.000	--	--	--	--	0.000
	--	193.92	356.99	--	--	--	--	550.91
	0	5	6	0	0	0	0	11
			0.00		***0.00***			***0.00***
19	--	--	0.000	--	0.000	--	--	0.000
	--	--	127.70	--	333.62	--	--	461.32
	0	0	2	0	13	0	0	15
				0.00		***1.36***	***1.06***	***1.21***
23	--	--	--	0.000	--	37.710	18.480	56.190
	--	--	--	95.26	--	2775.57	1745.29	4616.12
	0	0	0	1	0	13	18	32
						0.00	***0.00***	***0.00***
28	--	--	--	--	--	0.000	0.000	0.000
	--	--	--	--	--	34.27	150.85	185.12
	0	0	0	0	0	1	8	9
							0.00	***0.00***
29	--	--	--	--	--	--	0.000	0.000
	--	--	--	--	--	--	42.64	42.64
	0	0	0	0	0	0	1	1
			0.72	***7.80***	***2.54***	***0.42***	***0.00***	***4.44***
123	--	--	7.240	188.040	12.250	3.510	0.000	211.040
	--	--	1001.08	2410.21	482.42	841.01	18.14	4752.86
	0	0	13	16	4	9	1	43
				0.18				***0.18***
124	--	--	--	0.950	--	--	--	0.950
	--	--	--	515.54	--	--	--	515.54
	0	0	0	3	0	0	0	3
		0.00	***0.39***	***5.13***	***0.62***	***0.79***	***0.86***	***1.68***
All	--	0.000	8.140	188.990	12.250	41.670	18.480	269.530
	--	193.92	2098.56	3686.26	1985.85	5889.83	2140.19	15994.61
	0	5	31	32	27	44	35	174

Table 6. Estimates of eulachons as bycatch in from shrimp trawl catches. The estimates are made for both gears (otter trawls and beam trawls) for different areas of the British Columbia Coast, from June to December, 1997. The estimates of the ratio of eulachon weights to shrimp weights (in italics) are based on analyses of observer analyses of trawl catches from March to October, 1997. The number of observer samples is shown for the corresponding areas. The upper and lower estimates are the 95% confidence limits of bootstrap estimates of the mean rations from the observer data. The estimates of the tonnes of eulachons are the products of the hailed shrimp catches (in tonnes) by the eulachon:shrimp ratios.

Gear	Area	Stat. Area	Hail	Number Samples	Ratio: eulachons to Shrimp			Estimated tonnes of eulachon bycatch		
					lower	*mean*	*upper*	*lower*	*mean*	*upper*
Otter	NC	3,4,5	21.5	90	*0.009562*	*0.013996*	*0.019525*	**0.13**	**0.30**	**0.42**
Otter	CC	10,101,108,110,111	430.6	136	*0.173858*	*0.209875*	*0.250633*	**74.86**	**90.37**	**107.92**
Otter	WC	23, 123-125	742.9	114	*0.029640*	*0.069862*	*0.123451*	**22.02**	**51.90**	**91.71**
Otter	SOG	14-19,28-29	11.2	16	*0.000350*	*0.001233*	*0.002386*	**0.00**	**0.02**	**0.03**
Total (Otter trawls)								**97.01**	**142.59**	**200.08**
Beam	Area 12	12	144.7	25	*0.000000*	*0.000134*	*0.000395*	**0.00**	**0.02**	**0.06**
Beam	WCO	123-125	339.4	46	*0.021992*	*0.052169*	*0.090307*	**7.46**	**17.40**	**30.65**
Beam	WCI	23-25	266.2	32	*0.010154*	*0.016628*	*0.024156*	**2.70**	**4.43**	**6.43**
Beam	SOG	14-19,28-29	231.0	71	*0.000000*	*0.000109*	*0.000239*	**0.00**	**0.03**	**0.06**
Total (Beam trawls)								**10.16**	**21.88**	**37.20**
Total (both gears)								**107.17**	**164.47**	**237.28**

Appendix 1. Summary of the total shrimp (SH) and eulachon (E) weights, in kilograms, shown by Statistical Area, Month and Gear, from the Observer data. The '%Eulachon' is the ratio of eulachon catch weight to shrimp weight (shown here as a percentage). The 'towcode' is a number representing individual tows.

GEAR	STAT. AREA	MONTH	SH-Kg	E-Kg	%EULACHON	TOWCODE
OTTER	3	8	12.540	0.000	0.000	216
OTTER	3	8	41.320	0.000	0.000	202
OTTER	4	5	1.360	0.000	0.000	7
OTTER	4	5	2.270	0.000	0.000	17
OTTER	4	5	11.790	0.910	7.718	11
OTTER	4	5	14.060	0.000	0.000	9
OTTER	4	5	15.880	0.000	0.000	8
OTTER	4	5	24.490	5.440	22.213	10
OTTER	4	5	43.550	0.000	0.000	13
OTTER	4	5	143.790	0.000	0.000	12
OTTER	4	5	146.510	0.000	0.000	16
OTTER	4	5	161.930	0.000	0.000	14
OTTER	4	5	162.390	0.000	0.000	15
OTTER	4	8	5.440	0.250	4.596	255
OTTER	4	8	15.420	0.450	2.918	251
OTTER	4	8	19.750	0.250	1.266	208
OTTER	4	8	20.410	0.250	1.225	214
OTTER	4	8	21.320	0.450	2.111	211
OTTER	4	8	22.680	0.450	1.984	186
OTTER	4	8	22.930	0.250	1.090	227
OTTER	4	8	26.310	0.450	1.710	200
OTTER	4	8	29.030	0.450	1.550	205
OTTER	4	8	34.270	0.250	0.730	204
OTTER	4	8	35.180	0.910	2.587	222
OTTER	4	8	35.630	0.910	2.554	207
OTTER	4	8	36.080	0.250	0.693	210
OTTER	4	8	36.740	0.250	0.680	203
OTTER	4	8	38.810	1.360	3.504	221
OTTER	4	8	39.010	0.910	2.333	253
OTTER	4	8	39.010	0.000	0.000	254
OTTER	4	8	40.170	0.910	2.265	177
OTTER	4	8	40.820	0.250	0.612	228
OTTER	4	8	42.890	2.270	5.293	179
OTTER	4	8	42.890	6.800	15.855	178
OTTER	4	8	44.450	0.450	1.012	226
OTTER	4	8	45.360	0.910	2.006	223
OTTER	4	8	45.810	0.450	0.982	225
OTTER	4	8	46.520	0.250	0.537	220
OTTER	4	8	46.970	0.910	1.937	206
OTTER	4	8	47.170	0.450	0.954	224
OTTER	4	8	47.170	2.270	4.812	246
OTTER	4	8	48.130	0.910	1.891	245
OTTER	4	8	48.330	0.000	0.000	201
OTTER	4	8	50.600	0.450	0.889	212
OTTER	4	8	52.620	0.250	0.475	219
OTTER	4	8	53.520	0.450	0.841	209
OTTER	4	8	54.230	0.250	0.461	239
OTTER	4	8	56.500	0.910	1.611	249

GEAR	STAT. AREA	MONTH	SH-Kg	E-Kg	%EULACHON	TOWCODE
OTTER	4	8	56.950	0.910	1.598	243
OTTER	4	8	58.510	0.910	1.555	247
OTTER	4	8	58.970	0.910	1.543	244
OTTER	4	8	59.870	0.250	0.418	215
OTTER	4	8	60.580	0.250	0.413	242
OTTER	4	8	61.690	0.910	1.475	248
OTTER	4	8	63.750	0.250	0.392	217
OTTER	4	8	67.380	0.250	0.371	199
OTTER	4	8	69.850	0.250	0.358	194
OTTER	4	8	69.850	0.250	0.358	230
OTTER	4	8	70.100	0.450	0.642	232
OTTER	4	8	71.460	0.450	0.630	238
OTTER	4	8	74.190	0.250	0.337	229
OTTER	4	8	75.550	0.000	0.000	231
OTTER	4	8	77.110	0.000	0.000	237
OTTER	4	8	77.160	0.910	1.179	252
OTTER	4	8	77.570	0.250	0.322	197
OTTER	4	8	78.020	0.450	0.577	240
OTTER	4	8	78.470	0.910	1.160	182
OTTER	4	8	80.080	0.450	0.562	218
OTTER	4	8	80.080	0.910	1.136	250
OTTER	4	8	80.290	0.450	0.560	213
OTTER	4	8	83.010	0.450	0.542	233
OTTER	4	8	89.360	0.450	0.504	241
OTTER	4	8	90.270	0.250	0.277	198
OTTER	4	8	90.720	0.250	0.276	234
OTTER	4	8	91.420	0.450	0.492	236
OTTER	4	8	95.710	0.250	0.261	196
OTTER	4	8	102.060	0.250	0.245	235
OTTER	4	8	102.970	0.250	0.243	192
OTTER	4	8	105.230	0.450	0.428	187
OTTER	4	8	109.820	0.250	0.228	189
OTTER	4	8	111.380	0.250	0.224	193
OTTER	4	8	115.210	0.450	0.391	183
OTTER	4	8	120.000	0.250	0.208	191
OTTER	4	8	120.200	0.000	0.000	190
OTTER	4	8	123.630	0.450	0.364	181
OTTER	4	8	124.290	0.450	0.362	184
OTTER	4	8	127.010	0.250	0.197	180
OTTER	4	8	128.370	0.450	0.351	185
OTTER	4	8	128.370	0.450	0.351	188
OTTER	4	8	128.820	0.450	0.349	195
OTTER	10	8	272.610	239.500	87.854	403
OTTER	10	8	298.470	7.710	2.583	409
OTTER	10	8	303.910	7.260	2.389	404
OTTER	10	8	367.410	39.920	10.865	406
OTTER	10	8	374.670	29.940	7.991	407
OTTER	10	8	473.560	36.740	7.758	405
OTTER	10	8	522.540	84.820	16.232	408
OTTER	10	9	79.830	21.320	26.707	412
OTTER	10	9	114.310	88.450	77.377	426
OTTER	10	9	121.110	30.390	25.093	421
OTTER	10	9	132.900	71.670	53.928	424
OTTER	10	9	136.530	4.990	3.655	286

(continued)

GEAR	STAT. AREA	MONTH	SH-Kg	E-Kg	%EULACHON	TOWCODE
OTTER	10	9	136.990	8.620	6.292	280
OTTER	10	9	136.990	0.000	0.000	278
OTTER	10	9	162.840	41.730	25.626	427
OTTER	10	9	165.560	9.530	5.756	277
OTTER	10	9	168.280	32.660	19.408	423
OTTER	10	9	175.540	30.390	17.312	420
OTTER	10	9	181.440	23.130	12.748	429
OTTER	10	9	182.350	5.900	3.236	275
OTTER	10	9	182.350	6.350	3.482	285
OTTER	10	9	182.800	7.260	3.972	276
OTTER	10	9	183.250	7.710	4.207	281
OTTER	10	9	185.970	19.960	10.733	416
OTTER	10	9	199.130	7.260	3.646	422
OTTER	10	9	205.480	6.800	3.309	279
OTTER	10	9	220.900	29.480	13.345	411
OTTER	10	9	229.070	8.620	3.763	284
OTTER	10	9	229.970	16.780	7.297	282
OTTER	10	9	247.660	9.980	4.030	414
OTTER	10	9	258.100	0.910	0.353	428
OTTER	10	9	288.030	21.770	7.558	415
OTTER	10	9	296.650	12.250	4.129	283
OTTER	10	9	308.900	47.170	15.270	417
OTTER	10	9	352.440	80.290	22.781	418
OTTER	10	9	379.660	93.440	24.611	410
OTTER	10	9	453.140	115.210	25.425	425
OTTER	14	5	26.760	0.000	0.000	467
OTTER	14	5	58.970	0.450	0.763	466
OTTER	14	5	73.480	0.000	0.000	463
OTTER	14	5	75.750	0.450	0.594	464
OTTER	14	5	80.290	0.450	0.560	465
OTTER	14	5	134.720	0.000	0.000	468
OTTER	14	10	73.940	0.000	0.000	486
OTTER	14	10	100.240	0.000	0.000	487
OTTER	14	10	115.010	0.000	0.000	488
OTTER	14	10	129.530	0.000	0.000	489
OTTER	14	10	161.280	0.000	0.000	492
OTTER	14	10	231.580	0.000	0.000	491
OTTER	15	7	7.260	0.000	0.000	287
OTTER	15	7	8.620	0.000	0.000	292
OTTER	15	7	23.130	0.000	0.000	290
OTTER	15	7	31.750	0.000	0.000	288
OTTER	15	7	45.360	0.000	0.000	293
OTTER	15	7	46.270	0.000	0.000	291
OTTER	15	7	59.870	0.000	0.000	289
OTTER	15	7	84.820	0.000	0.000	294
OTTER	15	8	32.660	0.000	0.000	459
OTTER	15	8	52.620	0.000	0.000	461
OTTER	15	8	66.230	0.000	0.000	456
OTTER	15	8	70.760	0.000	0.000	458
OTTER	15	8	88.910	0.000	0.000	457
OTTER	15	8	92.990	0.000	0.000	460
OTTER	17	7	1.610	0.000	0.000	32

(continued)

GEAR	STAT. AREA	MONTH	SH-Kg	E-Kg	%EULACHON	TOWCODE
OTTER	17	7	6.150	0.000	0.000	33
OTTER	17	7	14.310	0.000	0.000	31
OTTER	23	10	91.220	0.910	0.998	438
OTTER	23	10	92.530	17.240	18.632	439
OTTER	23	10	113.900	1.360	1.194	445
OTTER	23	10	114.100	0.910	0.798	433
OTTER	23	10	114.560	17.240	15.049	443
OTTER	23	10	115.010	10.890	9.469	442
OTTER	23	10	136.580	1.810	1.325	435
OTTER	23	10	136.580	1.810	1.325	436
OTTER	23	10	136.780	9.530	6.967	434
OTTER	23	10	136.780	10.430	7.625	432
OTTER	23	10	159.920	26.310	16.452	431
OTTER	23	10	181.940	1.810	0.995	437
OTTER	23	10	183.960	7.260	3.947	444
OTTER	23	10	205.480	33.110	16.113	430
OTTER	23	10	229.320	2.720	1.186	446
OTTER	23	10	229.320	26.310	11.473	441
OTTER	23	10	343.170	23.590	6.874	440
OTTER	23	10	345.640	15.880	4.594	447
OTTER	107	7	277.400	86.180	31.067	382
OTTER	107	9	22.680	0.000	0.000	274
OTTER	108	7	45.810	113.400	247.544	519
OTTER	108	7	56.950	54.430	95.575	138
OTTER	108	7	82.350	32.210	39.114	135
OTTER	108	7	119.090	35.830	30.086	140
OTTER	108	7	141.320	9.070	6.418	376
OTTER	108	7	153.360	11.790	7.688	387
OTTER	108	7	160.370	40.370	25.173	141
OTTER	108	7	161.480	104.780	64.887	130
OTTER	108	7	161.530	79.380	49.143	507
OTTER	108	7	169.440	83.920	49.528	143
OTTER	108	7	177.610	161.030	90.665	137
OTTER	108	7	198.720	19.500	9.813	385
OTTER	108	7	200.490	53.980	26.924	374
OTTER	108	7	207.750	69.400	33.406	147
OTTER	108	7	220.240	75.750	34.394	133
OTTER	108	7	226.140	14.970	6.620	381
OTTER	108	7	229.520	90.720	39.526	129
OTTER	108	7	231.380	124.740	53.911	136
OTTER	108	7	233.150	92.530	39.687	134
OTTER	108	7	233.600	22.680	9.709	516
OTTER	108	7	235.210	10.430	4.434	392
OTTER	108	7	235.670	19.050	8.083	378
OTTER	108	7	235.870	67.130	28.461	132
OTTER	108	7	237.230	81.650	34.418	142
OTTER	108	7	238.180	12.250	5.143	384
OTTER	108	7	238.840	181.440	75.967	128
OTTER	108	7	239.800	30.390	12.673	390
OTTER	108	7	246.800	39.010	15.806	388
OTTER	108	7	259.050	22.230	8.581	389
OTTER	108	7	265.150	53.070	20.015	127
OTTER	108	7	267.870	48.080	17.949	379

(continued)

GEAR	STAT. AREA	MONTH	SH-Kg	E-Kg	%EULACHON	TOWCODE
OTTER	108	7	271.500	98.430	36.254	139
OTTER	108	7	271.950	106.600	39.198	131
OTTER	108	7	277.440	16.330	5.886	383
OTTER	108	7	286.220	52.620	18.384	375
OTTER	108	7	286.920	29.480	10.275	391
OTTER	108	7	293.070	50.350	17.180	123
OTTER	108	7	303.000	106.140	35.030	126
OTTER	108	7	312.070	92.080	29.506	144
OTTER	108	7	312.780	24.490	7.830	386
OTTER	108	7	324.120	114.760	35.407	145
OTTER	108	7	334.350	12.250	3.664	380
OTTER	108	7	336.570	118.390	35.175	125
OTTER	108	7	342.010	102.970	30.107	146
OTTER	108	7	343.370	58.970	17.174	498
OTTER	108	7	348.610	116.570	33.439	124
OTTER	108	7	356.530	66.230	18.576	497
OTTER	108	7	368.770	19.960	5.413	371
OTTER	108	7	380.610	16.330	4.290	377
OTTER	108	7	394.180	26.310	6.675	373
OTTER	108	7	417.310	15.880	3.805	372
OTTER	108	7	450.220	12.700	2.821	515
OTTER	108	7	456.770	34.020	7.448	500
OTTER	108	7	462.470	33.570	7.259	513
OTTER	108	7	464.940	26.760	5.756	502
OTTER	108	7	466.750	23.590	5.054	503
OTTER	108	7	469.720	40.820	8.690	514
OTTER	108	7	479.910	23.590	4.916	518
OTTER	108	7	507.370	29.480	5.810	501
OTTER	108	7	511.200	71.210	13.930	499
OTTER	108	7	515.080	29.030	5.636	510
OTTER	108	7	591.290	33.570	5.677	512
OTTER	108	7	595.120	29.480	4.954	504
OTTER	108	7	613.970	71.210	11.598	509
OTTER	108	7	680.650	21.320	3.132	517
OTTER	108	7	712.850	25.400	3.563	508
OTTER	108	7	714.870	35.380	4.949	505
OTTER	108	7	762.500	15.420	2.022	511
OTTER	108	7	775.200	33.570	4.330	506
OTTER	108	8	20.410	13.610	66.683	400
OTTER	108	8	33.570	1.810	5.392	399
OTTER	108	8	37.190	4.540	12.208	398
OTTER	108	8	42.180	2.270	5.382	402
OTTER	108	8	72.580	13.150	18.118	397
OTTER	108	8	108.410	4.540	4.188	153
OTTER	108	8	136.080	9.980	7.334	401
OTTER	108	8	244.490	170.100	69.573	155
OTTER	108	8	288.030	68.490	23.779	159
OTTER	108	8	294.840	81.190	27.537	150
OTTER	108	8	303.000	127.010	41.917	149
OTTER	108	8	305.720	50.350	16.469	154
OTTER	108	8	322.510	47.630	14.769	161
OTTER	108	8	343.370	68.040	19.815	163
OTTER	108	8	344.730	103.870	30.131	157

(continued)

GEAR	STAT. AREA	MONTH	SH-Kg	E-Kg	%EULACHON	TOWCODE
OTTER	108	8	391.450	39.010	9.966	166
OTTER	108	8	395.990	70.310	17.755	162
OTTER	108	8	417.310	41.280	9.892	160
OTTER	108	8	419.120	123.380	29.438	156
OTTER	108	8	427.290	115.210	26.963	152
OTTER	108	8	439.080	52.620	11.984	164
OTTER	108	8	502.130	68.490	13.640	158
OTTER	108	8	545.680	80.290	14.714	148
OTTER	108	8	545.680	117.940	21.613	151
OTTER	108	8	552.930	76.200	13.781	165
OTTER	108	9	11.340	0.000	0.000	272
OTTER	108	9	22.680	0.000	0.000	273
OTTER	110	9	328.400	89.810	27.348	419
OTTER	123	4	11.340	0.000	0.000	103
OTTER	123	4	34.020	0.000	0.000	107
OTTER	123	4	68.040	0.000	0.000	105
OTTER	123	4	108.860	22.230	20.421	106
OTTER	123	4	156.490	9.070	5.796	104
OTTER	123	7	0.000	0.000	0.000	113
OTTER	123	7	0.000	0.000	0.000	473
OTTER	123	7	40.820	23.590	57.790	122
OTTER	123	7	51.960	12.250	23.576	117
OTTER	123	7	65.770	0.000	0.000	119
OTTER	123	7	78.470	7.260	9.252	118
OTTER	123	7	86.640	10.430	12.038	114
OTTER	123	7	86.640	64.860	74.861	120
OTTER	123	7	100.700	11.340	11.261	121
OTTER	123	7	113.400	0.450	0.397	471
OTTER	123	7	113.400	0.450	0.397	480
OTTER	123	7	113.400	22.680	20.000	483
OTTER	123	7	140.620	4.990	3.549	477
OTTER	123	7	156.490	0.450	0.288	472
OTTER	123	7	158.760	3.630	2.286	476
OTTER	123	7	158.760	15.420	9.713	484
OTTER	123	7	181.440	8.620	4.751	482
OTTER	123	7	181.890	2.720	1.495	470
OTTER	123	7	192.330	36.290	18.869	116
OTTER	123	7	206.840	9.530	4.607	475
OTTER	123	7	227.710	23.130	10.158	469
OTTER	123	7	229.070	17.240	7.526	115
OTTER	123	7	261.730	2.720	1.039	481
OTTER	123	7	299.830	5.900	1.968	474
OTTER	123	7	319.790	5.440	1.701	478
OTTER	123	7	408.240	4.080	0.999	479
OTTER	123	9	90.970	1.360	1.495	452
OTTER	123	9	159.010	4.990	3.138	448
OTTER	123	9	227.250	5.900	2.596	451
OTTER	123	9	341.100	22.230	6.517	449
OTTER	123	9	680.650	53.520	7.863	450
OTTER	123	10	249.480	0.910	0.365	369
OTTER	123	10	304.360	0.450	0.148	367
OTTER	124	4	2.270	4.540	200.000	359
OTTER	124	4	22.680	0.000	0.000	111

GEAR	STAT. AREA	MONTH	SH-Kg	E-Kg	%EULACHON	TOWCODE
OTTER	124	4	37.650	6.800	18.061	109
OTTER	124	4	45.360	0.000	0.000	112
OTTER	124	4	90.720	0.000	0.000	108
OTTER	124	4	92.530	16.780	18.135	110
OTTER	124	7	136.330	0.250	0.183	97
OTTER	124	7	151.960	0.910	0.599	102
OTTER	124	7	158.760	0.250	0.157	93
OTTER	124	7	158.760	1.360	0.857	100
OTTER	124	7	181.440	0.450	0.248	92
OTTER	124	7	181.440	0.450	0.248	98
OTTER	124	7	204.120	0.450	0.220	88
OTTER	124	7	204.120	0.910	0.446	96
OTTER	124	7	208.650	3.630	1.740	101
OTTER	124	7	224.330	0.250	0.111	85
OTTER	124	7	226.800	0.250	0.110	90
OTTER	124	7	226.800	0.450	0.198	86
OTTER	124	7	226.800	0.450	0.198	91
OTTER	124	7	226.800	1.360	0.600	95
OTTER	124	7	226.800	3.180	1.402	94
OTTER	124	7	272.160	1.360	0.500	99
OTTER	124	7	317.520	0.450	0.142	87
OTTER	124	7	333.390	0.450	0.135	89
OTTER	124	8	54.430	4.540	8.341	20
OTTER	124	8	56.700	0.000	0.000	328
OTTER	124	8	68.040	0.250	0.367	330
OTTER	124	8	81.650	4.540	5.560	25
OTTER	124	8	92.990	0.450	0.484	349
OTTER	124	8	108.860	4.080	3.748	24
OTTER	124	8	158.760	0.250	0.157	329
OTTER	124	8	183.050	0.250	0.137	343
OTTER	124	8	183.710	0.450	0.245	345
OTTER	124	8	183.710	0.910	0.495	348
OTTER	124	8	183.960	0.250	0.136	346
OTTER	124	8	226.800	2.270	1.001	331
OTTER	124	8	229.070	0.450	0.196	347
OTTER	124	8	236.780	0.450	0.190	22
OTTER	124	8	274.430	1.810	0.660	342
OTTER	124	8	274.680	0.450	0.164	344
OTTER	124	8	276.490	19.050	6.890	18
OTTER	124	8	297.360	3.630	1.221	332
OTTER	124	8	351.540	11.340	3.226	19
OTTER	124	8	365.150	1.810	0.496	335
OTTER	124	8	371.950	2.720	0.731	334
OTTER	124	8	415.040	0.910	0.219	340
OTTER	124	8	435.450	1.360	0.312	341
OTTER	124	8	462.670	0.910	0.197	339
OTTER	124	8	478.540	10.430	2.180	21
OTTER	124	8	544.320	0.450	0.083	337
OTTER	124	8	546.580	9.070	1.659	333
OTTER	124	8	546.830	1.360	0.249	336
OTTER	124	8	598.750	0.450	0.075	338
OTTER	124	10	181.440	1.360	0.750	370
OTTER	125	3	36.290	0.000	0.000	4

(continued)

GEAR	STAT. AREA	MONTH	SH-Kg	E-Kg	%EULACHON	TOWCODE
OTTER	125	3	45.360	0.450	0.992	2
OTTER	125	3	45.360	0.910	2.006	1
OTTER	125	3	90.720	0.910	1.003	6
OTTER	125	3	90.720	2.720	2.998	5
OTTER	125	3	158.760	9.070	5.713	3
OTTER	125	4	1.360	3.180	233.824	360
OTTER	125	4	11.340	0.000	0.000	361
OTTER	125	4	22.680	0.000	0.000	357
OTTER	125	4	27.220	3.630	13.336	363
OTTER	125	4	34.020	0.000	0.000	366
OTTER	125	4	68.040	2.270	3.336	358
OTTER	125	4	68.040	2.720	3.998	354
OTTER	125	4	181.440	4.540	2.502	365
OTTER	125	4	204.120	5.900	2.890	355
OTTER	125	4	317.520	6.800	2.142	356
BEAM	12	8	91.620	0.000	0.000	520
BEAM	12	8	137.800	0.000	0.000	522
BEAM	12	8	221.800	0.000	0.000	523
BEAM	12	8	314.300	0.000	0.000	521
BEAM	12	9	6.804	0.000	0.000	538
BEAM	12	9	20.860	0.000	0.000	536
BEAM	12	9	22.680	0.000	0.000	535
BEAM	12	9	48.980	0.000	0.000	537
BEAM	12	9	58.960	0.000	0.000	530
BEAM	12	9	74.390	0.000	0.000	533
BEAM	12	9	77.110	0.000	0.000	532
BEAM	12	9	85.270	0.000	0.000	539
BEAM	12	9	87.540	0.000	0.000	531
BEAM	12	9	89.350	0.000	0.000	544
BEAM	12	9	108.800	0.000	0.000	540
BEAM	12	9	110.200	0.000	0.000	534
BEAM	12	9	111.100	0.000	0.000	524
BEAM	12	9	113.800	0.000	0.000	526
BEAM	12	9	132.900	0.000	0.000	541
BEAM	12	9	133.800	0.000	0.000	542
BEAM	12	9	136.500	0.454	0.333	527
BEAM	12	9	140.600	0.000	0.000	529
BEAM	12	9	185.000	0.000	0.000	543
BEAM	12	9	204.500	0.000	0.000	525
BEAM	12	9	289.300	0.000	0.000	528
BEAM	14	5	8.618	0.000	0.000	496
BEAM	14	5	36.280	0.000	0.000	295
BEAM	14	5	39.460	0.000	0.000	296
BEAM	14	5	46.260	0.000	0.000	269
BEAM	14	5	46.260	0.000	0.000	297
BEAM	14	5	51.710	0.000	0.000	270
BEAM	14	5	67.580	0.000	0.000	495
BEAM	14	5	68.940	0.000	0.000	271
BEAM	14	5	105.600	0.454	0.430	494
BEAM	14	5	141.900	0.454	0.320	493
BEAM	14	10	16.320	0.000	0.000	81
BEAM	14	10	18.590	0.000	0.000	84
BEAM	14	10	21.310	0.000	0.000	79

(continued)

GEAR	STAT. AREA	MONTH	SH-Kg	E-Kg	%EULACHON	TOWCODE
BEAM	14	10	22.680	0.000	0.000	80
BEAM	14	10	29.480	0.000	0.000	78
BEAM	14	10	32.200	0.000	0.000	82
BEAM	14	10	42.630	0.000	0.000	83
BEAM	15	7	61.930	0.000	0.000	353
BEAM	15	7	90.060	0.000	0.000	351
BEAM	15	7	102.500	0.000	0.000	350
BEAM	15	7	103.600	0.000	0.000	352
BEAM	18	4	18.590	0.000	0.000	257
BEAM	18	4	31.750	0.000	0.000	256
BEAM	18	4	38.550	0.000	0.000	258
BEAM	18	4	46.510	0.000	0.000	259
BEAM	18	4	58.510	0.000	0.000	260
BEAM	18	5	22.220	0.000	0.000	264
BEAM	18	5	26.300	0.000	0.000	263
BEAM	18	5	43.990	0.000	0.000	262
BEAM	18	5	57.150	0.000	0.000	261
BEAM	18	5	101.600	0.000	0.000	266
BEAM	18	5	105.600	0.000	0.000	265
BEAM	19	5	52.160	0.000	0.000	267
BEAM	19	5	75.540	0.000	0.000	268
BEAM	19	8	0.250	0.000	0.000	59
BEAM	19	8	0.250	0.000	0.000	66
BEAM	19	8	17.030	0.000	0.000	67
BEAM	19	8	20.660	0.000	0.000	68
BEAM	19	8	25.190	0.000	0.000	64
BEAM	19	8	25.850	0.000	0.000	62
BEAM	19	8	30.180	0.000	0.000	63
BEAM	19	8	31.750	0.000	0.000	61
BEAM	19	8	33.150	0.000	0.000	70
BEAM	19	8	33.360	0.000	0.000	65
BEAM	19	8	36.280	0.000	0.000	60
BEAM	19	8	37.890	0.000	0.000	71
BEAM	19	8	41.730	0.000	0.000	69
BEAM	23	7	95.250	0.000	0.000	306
BEAM	23	9	23.130	0.250	1.081	48
BEAM	23	9	48.530	4.536	9.347	46
BEAM	23	9	54.880	3.175	5.785	170
BEAM	23	9	90.710	0.000	0.000	167
BEAM	23	9	90.960	6.350	6.981	47
BEAM	23	9	100.200	0.250	0.250	72
BEAM	23	9	136.000	3.175	2.335	169
BEAM	23	9	227.900	0.907	0.398	171
BEAM	23	9	318.600	3.175	0.997	175
BEAM	23	9	364.000	1.361	0.374	174
BEAM	23	9	409.300	6.804	1.662	172
BEAM	23	9	454.700	4.082	0.898	173
BEAM	23	9	456.100	3.629	0.796	176
BEAM	23	10	18.140	0.250	1.378	310
BEAM	23	10	41.270	0.000	0.000	75
BEAM	23	10	41.320	0.250	0.605	314
BEAM	23	10	45.610	2.722	5.968	74
BEAM	23	10	50.340	2.268	4.505	73

GEAR	STAT. AREA	MONTH	SH-Kg	E-Kg	%EULACHON	TOWCODE
BEAM	23	10	50.590	0.000	0.000	76
BEAM	23	10	68.540	0.250	0.365	307
BEAM	23	10	73.270	0.000	0.000	77
BEAM	23	10	82.140	0.000	0.000	52
BEAM	23	10	91.210	0.000	0.000	313
BEAM	23	10	115.000	0.454	0.395	309
BEAM	23	10	127.700	0.250	0.196	308
BEAM	23	10	130.600	3.175	2.431	53
BEAM	23	10	131.000	0.250	0.191	312
BEAM	23	10	138.500	2.722	1.965	58
BEAM	23	10	167.800	2.268	1.352	57
BEAM	23	10	168.200	1.814	1.078	56
BEAM	23	10	203.600	1.814	0.891	55
BEAM	28	9	34.270	0.000	0.000	396
BEAM	28	10	8.618	0.000	0.000	325
BEAM	28	10	9.979	0.000	0.000	37
BEAM	28	10	10.880	0.000	0.000	327
BEAM	28	10	13.150	0.000	0.000	326
BEAM	28	10	18.590	0.000	0.000	39
BEAM	28	10	24.740	0.000	0.000	38
BEAM	28	10	28.570	0.000	0.000	36
BEAM	28	10	36.280	0.000	0.000	35
BEAM	29	10	42.630	0.000	0.000	34
BEAM	123	5	9.072	0.000	0.000	302
BEAM	123	5	32.200	0.000	0.000	318
BEAM	123	5	34.470	0.454	1.317	455
BEAM	123	5	47.620	0.000	0.000	319
BEAM	123	5	54.430	0.454	0.834	316
BEAM	123	5	54.880	0.454	0.827	315
BEAM	123	5	58.060	0.000	0.000	454
BEAM	123	5	59.870	0.000	0.000	317
BEAM	123	5	59.870	0.000	0.000	453
BEAM	123	5	127.000	0.454	0.357	299
BEAM	123	5	136.000	0.454	0.334	301
BEAM	123	5	145.600	4.536	3.115	300
BEAM	123	5	181.800	0.454	0.250	298
BEAM	123	7	52.160	0.454	0.870	320
BEAM	123	7	68.040	0.250	0.367	324
BEAM	123	7	143.300	0.454	0.317	303
BEAM	123	7	157.300	2.268	1.442	393
BEAM	123	7	318.400	0.907	0.285	321
BEAM	123	7	358.300	0.000	0.000	395
BEAM	123	7	380.100	0.454	0.119	394
BEAM	123	8	82.100	1.814	2.210	28
BEAM	123	8	110.000	3.629	3.299	27
BEAM	123	8	145.100	0.907	0.625	29
BEAM	123	8	145.100	5.897	4.064	30
BEAM	123	9	22.680	0.250	1.102	45
BEAM	123	9	22.930	0.250	1.090	49
BEAM	123	9	45.610	0.250	0.548	40
BEAM	123	9	90.710	0.454	0.500	44
BEAM	123	9	90.710	0.454	0.500	168
BEAM	123	9	91.170	0.250	0.274	50
BEAM	123	9	113.300	0.250	0.221	51
BEAM	123	9	136.500	0.454	0.333	41

(continued)

GEAR	STAT. AREA	MONTH	SH-Kg	E-Kg	%EULACHON	TOWCODE
BEAM	123	9	181.600	0.454	0.250	43
BEAM	123	9	227.200	0.907	0.399	42
BEAM	123	10	18.140	0.000	0.000	311
BEAM	124	7	113.600	0.250	0.220	323
BEAM	124	7	151.000	0.454	0.301	304
BEAM	124	7	250.800	0.250	0.100	322

(continued)

APPENDIX 2. BRIEF DESCRIPTION OF THE SHRIMP FISHERY AND THE 1997 BYCATCH PROGRAM

There are about 200 shrimp vessels that actively fish for shrimp in BC. The fleet consists of otter trawlers and beam trawlers. The 1997 bycatch program attempted to sample shrimp catches approximately in proportion to the anticipated catch, according to season and geographical (Statistical) area. As a basis for planning, we examined the fishing effort from 1995, in time and space, by both gears types. We anticipated that the 1997 shrimp catch would be approximately similar to the 1995 catch. Appendix2 Tables 1- 4 compare the beam trawl and otter trawl catch data or 1995, for all statistical areas. Appendix2 Table 1 shows the percentage of total catch. Beam trawls took 45% and otter trawls took 53%. There were some important differences in areas fished between the two gear types. Much of the beam trawl catch was from two areas (Area 23 or Barkley Sound and area 123 - offshore of Barkley Sound). In contrast the otter trawls took very little from Area 23. Almost all of the otter trawl catch was from areas offshore of the west coast of Vancouver island - Areas 123-125. Appendix2 Table 1 shows the distribution of catch, as a percentage of the total annual catch, by statistical area. The exact distribution changes annually, and recently fishing effort has increased in Area 12 (Johnstone Strait). A key assumption of a bycatch observer program is that bycatch is function of total catch - and total catch will be an approximate function of effort.

Comparison of gear types. There are more beam trawlers in the fleet. Appendix2 Table 2 shows the number of tows by area for both gear types. Beam trawlers made more tows in 1995 (23,801) compared to otter trawlers (12, 951). Appendix2 Table 3 shows the average catch per tow (kg/tow) and Appendix2 Table 4 the average tow duration (hours). In general beam trawlers make longer sets (2.3 hours duration) and have smaller catches (248 kg) than otter trawls that have shorter tows (1.3 hours) and larger catches. The total number of days fished (Appendix2 Table 5) differs: there are approximately about 4 times as many fishing days by beam trawlers than otter trawlers. Therefore, if the total catches of the two gear types are approximately the same (Appendix2 Table 1) the total bycatch may be about the same - even though there are fewer days fished in the otter trawls. Therefore the observer effort should be split, approximately equally between the two gear types, and the anticipated consequence is that the 'coverage' will appear to be greater on the otter trawl vessels that fish fewer days but make larger catches with shorter tows.

Comparison by season In addition to adjusting for differences of the two main gear types, observer effort must be spread both seasonally and geographically. This will require annual adjustments and - perhaps within-year adjustments. Appendix2 Table 6 shows the distribution of fishing days, by gear type, Statistical Area and month. Most of the fishing effort occurs in the 5-6 months of the later spring and summer and most occurred on the west coast of Vancouver Island, either in the inshore or offshore areas. To simplify the review of the season distribution of fishing days, a condensed table is shown in Appendix2 Table 7.

Appendix 2. Table 1. Brief summary of the number of days fished, in 3 different times, by all shrimp vessels in 1995. A detailed table, showing all data by month and statistical area, is shown in Table 2.

Area	Jan-June	July-Aug	Sept-Dec	All periods	Percent
Unknown	96	78	98	272	
NC	379	80	321	780	6.6 %
CC	82	28	133	243	2.0 %
Georgia	1724	250	1443	3417	28.7 %
WCVI	816	677	974	2467	20.7 %
123	1098	1289	1216	3603	30.3 %
124+	439	457	500	1396	11.7 %
All	4634	2859	4685	12178	100 %

Appendix 2. Table 2. Detailed summary of the of number of days fished, by both gear types, by area and month, in 1995.

AREA	J	F	M	A	M	Jn	Jl	Ag	S	O	N	D	ALL
0	9	8	11	25	19	24	37	41	50	34	11	3	272
2						2					2	2	6
3			2	1	1	1			6				11
4	1	29	84	73	51	20	12	60	109	48	43	61	591
5	4		30	35	17			8	5	14	15	16	144
6				15	13								28
9			5	21			17	4	1				48
10						1	1						2
12		2	20	7	4	1	4	2	9	52	48	23	172
13		2	2					1	2	4	12		23
14	39	64	64	77	41	52	20		10	17	30	38	452
15	57	48	17	1	3	2	8	7	42	34	33	40	292
16					4				2				6
17	13	18	33	42	59	22	10	14	48	67	73	84	483
18	17	16	6	22	20	15	17	3	3	27	40	29	215
20											1		1
21						1							1
23	21	45	84	120	285	243	277	398	347	420	154	32	2426
24				5		1	1						7
25									1	9	7		17
27						11		1				4	16
28	22	38	66	103	144	107	42	69	88	81	108	57	925
29	48	58	133	116	90	43	10	49	198	99	134	43	1021
108					1	20							21
109						1							1
111						1							1
121			3	5	29	44	40	54	26	9	3	2	215
123	9	35	59	188	364	362	525	670	710	351	95	20	3388
124	1	10	25	39	75	39	119	144	201	49	8		710
125	6	9	25	46	72	42	111	60	155	53	28		607
126				7				1	2				10
127				4	15	24	16	6	4				69
All	247	382	669	952	1307	1079	1267	1592	2019	1368	845	454	12181

Appendix 2. Table 3. The number of fishing days, by year (1987-1996) and month (1-12)Year for (a) beam and (b) otter trawlers - summed from all areas of the coast

a. Beam trawls

Month	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1	179	220	137	136	202	139	161	267	238	386
2	338	379	205	211	306	234	280	277	347	593
3	397	366	318	424	503	418	332	437	608	676
4	360	372	372	362	550	469	465	395	785	718
5	341	442	461	451	508	680	531	453	1037	1239
6	303	454	216	160	427	376	272	519	834	1277
7	359	244	50	61	192	112	49	338	920	1200
8	228	156	62	36	90	129	45	58	1099	975
9	523	229	323	373	492	332	276	437	1539	1075
10	425	335	406	433	523	384	450	517	967	688
11	318	312	354	358	243	301	246	308	688	163
12	265	310	297	174	247	241	266	245	426	
All	4036	3819	3201	3179	4283	3815	3373	4251	9488	8990

b. Otter trawls

Month	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1		1	3	12	11	12	4	12	9	35
2		2	3	24	15	26	55	70	35	67
3		6	4	26	61	54	77	98	61	89
4		22	34	60	100	78	46	100	167	145
5	24	97	125	151	113	151	84	203	258	327
6	70	168	82	85	235	76	65	302	239	396
7	172	199	61	65	189	44	110	173	334	474
8	141	83	53	54	124	89	122	109	477	426
9	163	40	119	162	237	54	179	137	451	319
10	97	84	92	67	100	64	164	62	341	171
11		6	15	45	11	11	41	10	119	47
12	9	1	18	12	9	6	8	22	28	
All	676	709	609	763	1205	665	955	1298	2519	2496

Appendix 2. Table 4. Summary of the total number of minutes fished by year and month for beam and otter trawls. Beam trawls exceed the otter trawls. In 1975, they accounted for 75% of the minutes fished. Note that this is slightly lower than the numbers of days.

a. Beam trawls

Month	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1	53809	61437	35671	34941	62477	43425	38510	75099	60569	107190
2	99636	110360	66002	59436	90695	76737	81345	70675	98165	167952
3	125447	114824	99603	133765	150367	134097	99674	131346	182180	196723
4	106728	115170	108583	108893	164811	148662	149918	119907	222165	226159
5	98168	144980	160308	163367	160912	231091	168002	149345	331361	413935
6	86411	165601	82585	49168	158022	132674	88352	193283	297738	434911
7	109586	89975	13805	22685	64185	41335	17350	125899	344351	437544
8	70237	51683	18005	12070	29490	41770	15590	20240	399343	347283
9	162344	72472	113480	127995	177827	112057	79201	145779	532419	376638
10	117923	95908	135532	126838	160129	120733	131872	146177	290951	212264
11	86564	88197	109720	94478	68465	79133	71765	89435	179855	46937
12	65035	81987	81164	50305	70011	60262	68045	61798	98834	--
All	1181888	1192594	1024458	983941	1357391	1221976	1009624	1328983	3037931	2967536

b. Otter trawls

Month	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1	--	300	830	2465	3085	1990	1475	4015	2860	10816
2	--	345	545	7525	3685	4660	17915	21805	10617	22104
3	--	2125	1140	6920	15520	10162	17231	28085	19211	25085
4	--	5910	11360	20578	32684	21706	11780	33581	66787	45683
5	5774	35035	48100	57222	37920	45974	29444	85181	102551	136402
6	19852	69329	32668	28923	87927	24195	22181	160472	98546	170169
7	65287	92592	22011	27266	84246	15878	53985	93775	148513	218487
8	54638	33848	19640	23433	53342	33879	67728	58168	192730	199014
9	59010	13865	44664	65949	100468	17943	77595	58012	177809	139433
10	38045	26593	30090	24227	35975	15755	66350	25275	123438	58284
11	--	1642	3785	13870	2130	2390	14151	1885	38854	12510
12	2020	300	6205	3650	1900	1820	2480	6324	7821	--
All	244626	281884	221038	282028	458882	196352	382315	576578	989737	1037987

Appendix 2. Table 5. Summary of the total catch, in tonnes, by month and year between beam trawls (a) and otter trawls (b). Total catches are approximately equal between gear types.

a. Beam trawls

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	All
87	30.40	51.90	59.83	55.33	82.33	248.87	436.09	225.42	588.67	206.27	96.86	29.40	2111.36
88	37.72	75.85	60.00	82.23	269.82	470.23	278.34	83.94	129.62	180.98	84.88	59.49	1829.09
89	26.40	44.05	62.11	119.64	253.91	176.01	31.12	48.47	227.71	202.17	63.94	40.25	1295.79
90	17.32	38.27	99.86	116.10	244.91	87.09	41.14	17.64	253.61	164.97	79.80	27.58	1188.30
91	52.42	61.96	141.65	231.92	269.19	289.28	132.27	46.31	375.72	205.73	42.70	36.37	1885.52
92	27.78	59.57	227.06	314.67	567.73	275.06	198.95	112.71	240.81	155.16	118.78	49.19	2347.48
93	30.21	122.84	146.35	146.35	383.45	151.94	17.28	13.94	96.89	197.27	57.11	40.88	1404.50
94	59.03	67.92	133.12	134.11	232.34	396.69	330.35	26.54	321.76	241.04	58.86	52.07	2053.83
95	44.00	125.79	303.76	355.72	665.44	941.57	1053.46	1087.08	1138.03	443.89	210.36	95.60	6464.69
96	96.30	286.69	358.62	453.51	830.96	937.09	1075.43	760.58	759.09	389.55	65.44	--	6013.26
All	421.58	934.84	1600.36	2009.58	3800.08	3981.83	3594.41	2422.64	4131.91	2387.03	878.73	430.84	26593.81

b. Otter trawls

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	All
87	--	--	--	--	21.27	107.11	725.22	667.45	784.05	293.07	--	0.79	2598.96
88	0.51	1.13	17.25	36.61	411.27	885.22	1028.13	299.69	110.70	344.40	5.87	2.83	3143.62
89	0.47	0.23	0.65	56.54	430.97	427.21	425.66	367.51	508.94	337.62	13.71	3.40	2572.91
90	21.14	25.49	12.58	187.26	474.54	330.79	379.79	252.22	697.49	210.18	108.95	3.53	2703.96
91	7.91	2.33	39.52	246.15	301.19	1146.31	785.37	388.61	787.74	278.00	9.64	1.06	3993.83
92	2.14	5.11	67.95	152.98	453.76	256.82	253.44	559.91	398.10	333.33	6.42	2.04	2492.00
93	15.66	438.47	222.12	226.77	492.44	478.06	631.12	850.48	662.63	415.32	105.75	4.85	4543.66
94	30.55	182.05	207.46	234.11	855.17	1086.43	525.93	458.51	342.25	171.77	4.36	5.28	4103.88
95	14.74	66.36	136.60	485.82	820.59	679.42	1300.66	1452.89	1498.75	839.78	243.52	46.65	7585.77
96	27.55	89.27	203.29	265.14	921.18	918.11	1038.78	1070.60	743.16	265.30	46.36	--	5588.74
All	120.66	810.44	907.43	1891.39	5182.39	6315.46	7094.10	6367.86	6533.81	3488.77	544.58	70.43	39327.33

Appendix 2. Table 6. Summarizes the catch rates, in kg/min by month and year between beam and otter trawls.

Beam trawls

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	All
87	0.7145	1.0403	0.5927	0.5159	1.1371	1.9169	1.7641	2.3393	1.8164	1.2928	1.6828	0.7833	1.2561
88	0.8197	0.7789	0.8137	0.7674	1.0117	1.5098	2.1391	1.1621	1.5455	2.2280	0.7404	0.6860	1.1400
89	1.2150	1.0107	0.7209	0.9578	1.0826	1.1637	4.1488	1.6245	1.0301	1.3701	0.7205	0.7986	1.1556
90	0.5392	0.5673	0.9654	1.1909	1.1394	1.0939	1.6108	2.2210	1.2915	1.3175	1.0971	0.7822	1.0929
91	0.7801	0.8198	2.9241	1.2284	1.1667	1.4341	2.7613	1.5198	1.3211	1.2084	0.6248	0.5632	1.4237
92	0.6325	0.9823	2.0467	3.6693	2.8665	2.5992	4.8202	3.3637	2.9968	2.0319	3.0007	0.9640	2.5511
93	0.7282	2.5923	3.1060	2.0301	2.6622	2.1544	0.9462	0.7629	1.5116	1.4667	1.4861	0.9355	1.8848
94	0.8466	1.1121	1.1045	1.1684	1.6860	1.6143	1.5286	1.8811	1.8042	1.6677	1.8884	2.0095	1.5381
95	1.7293	1.5695	1.8711	1.8901	1.7710	2.7084	2.0015	1.8485	1.9321	1.6739	1.4306	1.1148	1.8214
96	1.0136	1.3266	1.7192	2.0207	2.7689	1.9531	2.0731	1.4089	1.7706	1.5574	1.2574	--	1.7651
All	0.9376	1.1942	1.6124	1.6035	1.8384	1.9078	2.3208	1.8108	1.7169	1.5848	1.3822	0.9349	1.5846

Otter trawls

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	All
87	--	--	--	--	2.9561	2.1547	4.2555	8.0016	4.2673	2.8656	--	0.7622	3.4308
88	1.7000	3.2754	5.1458	6.1954	8.4778	11.0287	9.6294	7.6524	6.9756	7.4418	2.1780	9.4333	7.2757
89	0.5497	0.3349	0.5711	3.4859	3.2713	8.5831	23.1096	22.2620	7.7475	15.0870	7.4757	0.5471	9.4342
90	7.4552	3.2598	2.3420	7.7740	10.8220	9.0551	10.7845	12.7866	13.0801	10.0362	5.0616	0.9660	7.8210
91	2.0288	0.3556	1.7228	3.9838	14.6097	7.0554	9.2837	5.1436	4.8919	6.7781	9.6207	0.5660	5.8015
92	1.0378	1.0871	3.9104	5.9058	3.9543	5.4411	13.5127	14.0609	20.7282	6.4266	2.4649	1.1236	5.7585
93	10.3825	8.1227	6.7345	5.8051	14.5033	17.0696	8.8828	8.6782	9.6572	4.0763	4.0664	2.5749	7.3396
94	8.7996	5.7599	3.8664	3.0856	4.5867	5.0578	4.8536	7.0151	4.8731	4.7900	2.9078	0.6422	4.4389
95	3.0019	7.0583	4.7517	6.4924	5.7168	5.3010	7.8082	6.7871	7.3092	5.3099	3.8847	3.6299	5.7261
96	1.7083	2.7798	5.5498	4.1722	8.9505	5.7472	3.4385	4.3927	4.1495	3.1241	3.1285	--	4.4850
All	3.7028	3.8421	4.2697	5.1293	7.4797	6.3956	7.3008	7.5113	6.5634	5.7283	3.8892	2.0746	5.7580

Appendix 2. Table 7. Summary of the numbers of tows, by year and month (where 1 = Jan, 2 = Feb. etc) for (a) beam trawlers and (b) otter trawlers.

Otter trawls

Month	87	88	89	90	91	92	93	94	95	96	All
1	356.00	384.00	252.00	248.00	415.00	262.00	288.00	523.00	438.00	845.00	4011.00
2	678.00	773.00	461.00	422.00	640.00	451.00	632.00	532.00	732.00	1397.00	6718.00
3	790.00	742.00	695.00	846.00	1098.00	944.00	661.00	941.00	1269.00	1590.00	9576.00
4	740.00	801.00	817.00	741.00	1309.00	1041.00	886.00	917.00	1799.00	1807.00	10858.00
5	654.00	1070.00	1288.00	1110.00	1151.00	1749.00	1206.00	1100.00	2664.00	3568.00	15560.00
6	626.00	1290.00	610.00	343.00	1046.00	939.00	622.00	1478.00	2374.00	3783.00	13111.00
7	839.00	639.00	94.00	123.00	446.00	278.00	104.00	1030.00	2808.00	3710.00	10071.00
8	563.00	372.00	156.00	75.00	198.00	289.00	110.00	153.00	3182.00	2953.00	8051.00
9	1279.00	510.00	860.00	890.00	1267.00	753.00	611.00	1164.00	3992.00	3018.00	14344.00
10	875.00	668.00	933.00	789.00	1171.00	791.00	1042.00	1123.00	2308.00	1760.00	11460.00
11	587.00	623.00	677.00	612.00	440.00	589.00	470.00	519.00	1442.00	354.00	6313.00
12	443.00	549.00	559.00	344.00	460.00	426.00	486.00	405.00	793.00	--	4465.00
All	8430.00	8421.00	7402.00	6543.00	9641.00	8512.00	7118.00	9885.00	23801.00	24785.00	1.15E+05

	87	88	89	90	91	92	93	94	95	96	All
1	--	1.00	9.00	29.00	40.00	29.00	15.00	59.00	40.00	114.00	336.00
2	--	9.00	8.00	93.00	43.00	50.00	266.00	294.00	152.00	245.00	1160.00
3	--	34.00	11.00	77.00	167.00	169.00	283.00	382.00	247.00	359.00	1729.00
4	--	106.00	156.00	289.00	436.00	298.00	193.00	445.00	907.00	629.00	3459.00
5	73.00	508.00	715.00	804.00	543.00	655.00	478.00	1147.00	1421.00	1536.00	7880.00
6	253.00	997.00	492.00	430.00	1319.00	340.00	353.00	1981.00	1279.00	1990.00	9434.00
7	847.00	1255.00	315.00	359.00	1135.00	239.00	735.00	1076.00	1969.00	2276.00	10206.00
8	766.00	451.00	287.00	291.00	682.00	518.00	827.00	641.00	2550.00	2091.00	9104.00
9	681.00	187.00	641.00	786.00	1250.00	254.00	974.00	717.00	2360.00	1307.00	9157.00
10	372.00	388.00	389.00	294.00	439.00	261.00	767.00	297.00	1471.00	611.00	5289.00
11	--	29.00	44.00	175.00	25.00	36.00	153.00	15.00	461.00	156.00	1094.00
12	11.00	1.00	60.00	35.00	18.00	16.00	27.00	55.00	94.00	--	317.00
All	3003.00	3966.00	3127.00	3662.00	6097.00	2865.00	5071.00	7109.00	12951.00	11314.00	59165.00